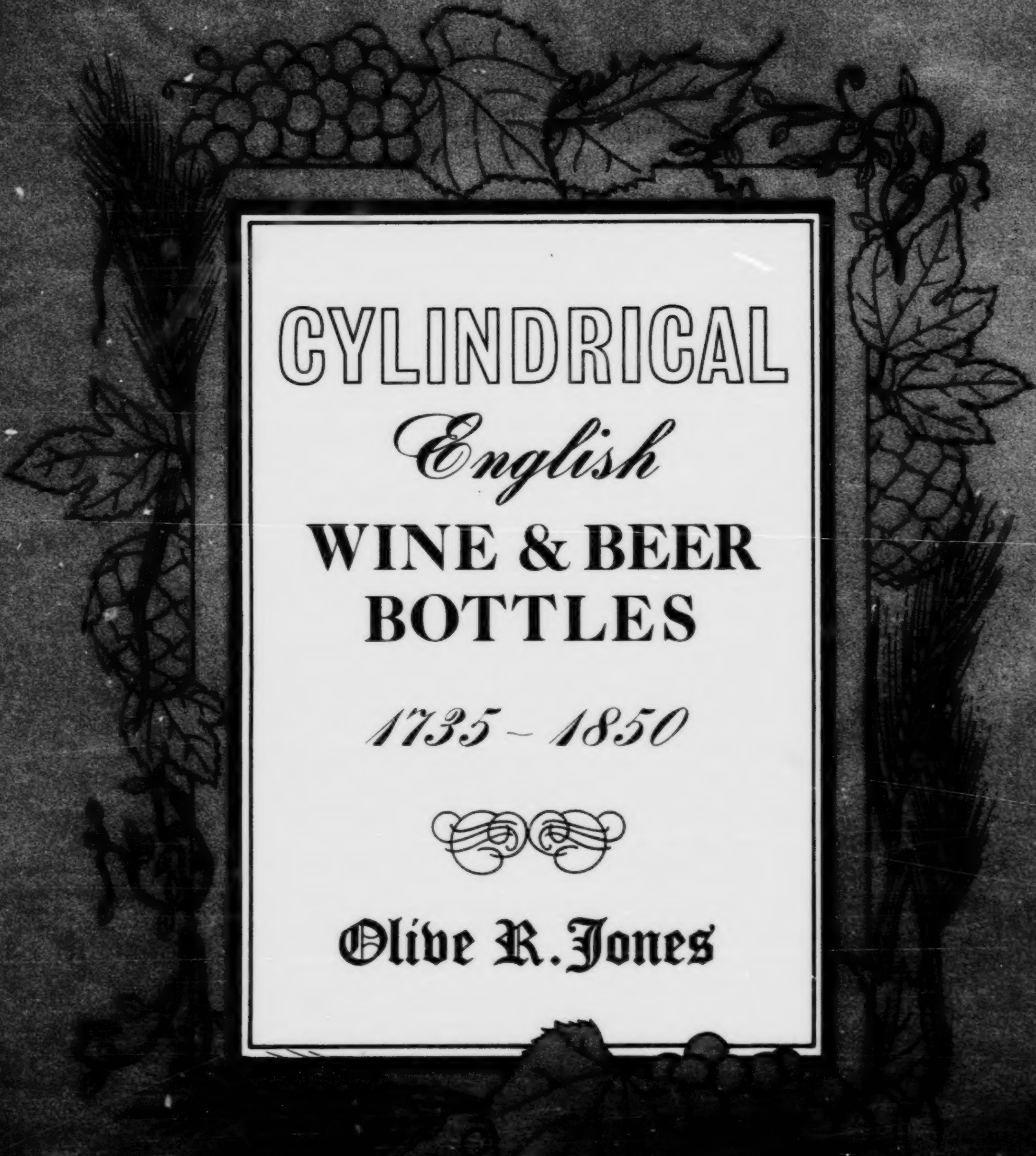

CYLINDRICAL *English* WINE & BEER BOTTLES

1735 – 1850

Olive R. Jones

Cylindrical English Wine and Beer Bottles 1735-1850

Olive R. Jones

Studies in Archaeology
Architecture and History

National Historic Parks and Sites Branch
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ABSTRACT

The "wine" bottle was the principal product of British bottle-glass factories in the 18th and early 19th centuries. The bottles were used to ship, store, mature, and serve a variety of products, primarily beverages, and were widely used not only in Britain but also in her colonies and in other countries that traded with Britain.

For this study 211 cylindrical sealed and dated bottles and 127 complete undated bottles were examined to establish criteria for dating cylindrical "wine" bottles made between 1735 and 1850. Date ranges for changing finish styles and manufacturing techniques were established. The dates of introduction for dip moulds, the three-piece mould, the finish-forming tool, and the snap case were investigated, with some success. Using the regression technique, measurement data were used to develop a formula for estimating the capacity of bottles and formulas for estimating the date of manufacture for complete bottles, neck, and base fragments. The dating formula results can be used to estimate mean manufacturing dates for "quart" bottles from archaeological assemblages.

Based on capacity, body height, base diameter, and dates of manufacture, four distinct body styles have been isolated: a wine-style, beer-style, undersized beer-style, and imperial wine-style.

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INTRODUCTION

One of the most successful containers produced by English glass factories has been the dark green glass "wine" bottle. Innumerable fragments of these bottles are found in Canada and the United States and in former British colonies throughout the world. Stopped with cork, the bottles made airtight, inert, and sturdy containers for wine, porter, ale, cider, distilled liquors, and other products.

Introduced in the mid-17th century, the English "wine" bottle underwent major and minor changes in the shape and size of the finish, neck, shoulder, body, and base. In the mid-17th century the bottles were tall with a long neck and globular body. The bottle was later shortened with a body wider at the shoulder than at the base. By 1700 the bottles again had globular bodies but with very short necks. In the mid-1720s the bottle was lengthened and the sides of the body flattened, the body tapering outward from the shoulder to the base. In the late 1730s the cylindrical body was introduced. In the early period the bottle was short but by the end of the 18th century a taller version had become established. The taller bottle, in dark green glass, is still used today for certain types of wines, principally sherry.

Date ranges for these changes have been established by 20th-century researchers using bottles with dated or datable seals attached to them, or from dated archaeological contexts (Price 1908: 116-25; Leeds 1914, 1941; Buckley 1931; Noël Hume 1961, 1969: 60-71; McKearin and Wilson 1978: 202-21). I found, however, that it was very difficult to match neck, body, and base fragments from archaeological excavations to the bottles illustrated in these chronologies. The illustrations were generally too small to show details of the bottles; the authors emphasized general trends rather than minute changes in individual features and described those trends in descriptive and comparative terms which are subject to individual interpretation. It was also difficult to assess the range of acceptable variation within a given group. The cylindrical "wine" bottle in particular was in production over such a long period that subtle changes such as alterations in body proportions, changes in the lip and string rim shapes, and in the manufacturing process are all that can be used to date individual examples.

For this study I chose to concentrate on the cylindrical body form produced between the late 1730s and ca. 1850. The changes taking place on the cylindrical "wine" bottle were not as well covered in the literature or as easy to identify as the dramatic changes that took place on the earlier forms. Yet hundreds of thousands of fragments of the cylindrical bottles are found on archaeological sites in Canada and the United States and dating these fragments is a constantly recurring task. I also wanted to show that measurement data could be used to date individual bottles and fragments instead of depending on subjective and comparative descriptive terms. To do this I had to confine myself to one body form to get a consistent group of measurements.

The ca. 1850 end date for the study was dictated by circumstances. The practice of applying seals to bottles began dying out in the 1820s. I examined only ten sealed bottles dating between 1830 and 1858. By the second quarter of the 19th-century glass factories in other countries, primarily the United States, began making bottles in the same style. Also, in the second half of the 19th century the "wine" bottle began to be replaced by a wide variety of other bottle styles so that the occurrence of the form in contexts dating after ca. 1860 is significantly reduced. The ca. 1850 end date has, then, been a convenient cut-off date.

The bottles used in this study generally have body diameters 1, 2, and 3 (see Measurements) decreasing towards the base although in some examples all three diameters are the same. A few examples (e.g. Appendix A, No. 5) looked cylindrical although the measurements increased slightly towards the base. The earliest example I examined was dated 1737 but other authors record examples dated as early as 1734-35 (Dumbrell 1983: 91). Mallet-shaped bodies, which immediately preceded the cylindrical form and co-existed with it for some time, increased in diameter toward the base.

My main objective was to establish criteria such as measurements, shape changes, and manufacturing techniques that could be used to establish a period of manufacture for complete and fragmentary cylindrical "wine" bottles found in North American archaeological sites of the ca. 1735 to 1850 period. A secondary objective was to examine the role of the "wine" bottle as a container.

THE DARK GREEN GLASS TRADITION IN ENGLAND

In the early years of the 17th century English glassmakers switched from wood- to coal-fired furnaces. The subsequent changes in furnace design and increased caloric efficiency led, among other things, to the development of new types of glass. One of these was the durable dark green glass used so extensively in the production of containers during the mid-17th to mid-19th centuries. Godfrey (1975: 229) argues persuasively that the dark green glass was a deliberate invention, probably devised by Sir Kenelm Digby in the early 1630s.

The new glass competed successfully, not only with its paler and more fragile predecessor but also with stoneware, for the expanding market in bottles of larger and standard capacities — gallons, pottles, quarts, pints, and half-pints (Godfrey 1975: 226-32). A series of bills dating between 1651 and 1692 from the Worshipful Company of Glass Sellers and others to the fifth earl of Bedford attest to the growing popularity of glass bottles during the second half of the 17th century. Between 1671 and 1691/92 the earl ordered more than 1120 dozen quart glass bottles. During this 20-year period the price of stoneware quart bottles remained relatively constant at 3s. while that of glass quarts fell from 4s. to 2s. 6d. At the latter price, achieved in 1687, the earl ordered 832 dozen bottles over the next six years (Thorpe 1938: 193, 201-2).

By the end of the 17th century the bottle-glass market had become so large that there were about 42 glasshouses producing bottles in England with an annual output of 240 000 dozen, nearly three million single bottles (Wills 1977: 30). English bottles blown in dark green glass acquired a reputation for strength and eventually factories using coal-fired furnaces to produce similar types of bottles were established in several countries in Europe (see Scoville 1968: 41-48; McNulty 1971: 95-97).

A great variety of forms were blown in the dark green glass, many of which cannot now be positively identified. By 1677 a wide range of sizes and shapes of containers were in production as well as chemical wares and miscellaneous items (Thorpe 1938: 196). By the mid-18th century the range had expanded considerably. An advertisement for 1762 describes some of these wares:

> At the Glass House in Gravel Lane, Southwark, are made best Mould Wine Bottles of all sizes, best champagne Bottles, Mould Pottle Bottles, commonly called Scotch Pints; Gallon Squares for Sea service; Pottle and Quart Squares for Oil, Olives, Anchovies and Pickles; Pints and Half-Pint Squares for Snuffs and Mustard; Pint, Quart and Pottle Fruit Bottles for Pastry Cooks; Variety of

> Chemical Ware, as Retorts, Receivers, Bolt heads; large Bottles from one to eight, ten to twelve gallons; Globes of all sizes, from 20 to 30 Gallons for Aquafortis; from 100 to 160 Gallons for oil and spirit of vitriol; Imparting Glasses for Refiners; large Mellon glasses for gardeners; and all other goods in the Bottle-Glass way, at the lowest price. All orders will be diligently observed by Thomas Flower, John Barrass. All the above goods are doubly anneal'd (quoted in Buckley 1930: 148-49).

From the detailed Day Book kept at Sir John Hussey Delaval's bottle glasshouse in Hartley Pans, Northumberland, during 1 July 1781 to 30 June 1782, the following containers were made, in varying quantities: champagnes; commons (some marked R&H, Ellison, Dog and Duck); moulded pints; moulded half pints; common pints; Winchester half pints, quarts, N.M. quarts, and W.M. pints; squares in quart, pottle, six-quart, and gallon sizes; half pint and pint chest squares; gooseberrys; Corbyn pints and quarts (some marked J. Ellison); olive pints and quarts; eight square half pints and pints; rounds in pint, two-quart, pottle (narrow and wide mouth), three-quart, six-quart, gallon, two-gallon, three-gallon, four-gallon, five-gallon, and eight-gallon sizes; quart squares, anchovie mouth, wallnutt mouth, wallnutt, anchovie, and capers; pint and pound mustard squares; pottle narrow mouth; decanters; snuff squares in seven-, eight-, fourteen-, and sixteen-ounce sizes; and finally, Scotts Pints. In addition to the containers they also made a wide range of chemical and pharmaceutical wares. This was a particularly innovative period at the glasshouse as they had just hired a glassman, named William Axley, who specialized in large "hollow" wares such as rounds, receivers, globes, bodeys, and bolt heads (Northumberland County Record Office, 2DE 11/3). A slightly later Day Book from the same factory, dated 26 February 1787 to 19 October 1787, records a similar but considerably less varied range of wares (N.C.R.O. 2DE 11/6). Two additions were French champagnes and ale pints and quarts (some marked T.B. and R & B).

The bread and butter wares from the Hartley Pans factory were the champagnes (also called moulded champagnes, moulds, and champagne wine quarts), commons, and moulded pints, the champagnes being the most common item. For example, in the week ending 26 January 1782 the stock on hand included 26 674 dozen champagnes, 7725 dozen commons, and 281 dozen moulded pints. The champagnes and commons were made daily at the factory and were always the major items in the regular shipments sent to the firm's London dealer. From at least the 1740s onward these terms were also used by other English glassmakers and clearly refer to the most common bottles (Smith 1975: 55; Buckley 1932: 245; Buckley 1930: quoted earlier). Comparing the importance of this group of bottles with the numerically overwhelming presence of the dark green glass "wine" bottles from archaeological sites, one has to assume that the terms champagnes, moulds, and commons must refer to "wine" bottles. The differences between the types may relate to quality, manufacturing technique, size (see Capacity), or shape (see Bodies) but firm evidence is lacking. On one occasion the champagnes cost considerably more than the commons but on another they were the same price (Buckley 1932: 245; N.C.R.O. 2DE 11/9/24). One reference suggests that there was sometimes a difference in the glass itself:

> Mr. Harrison sent Too pattern Bottles, the one Champain and the other one Common Bottle, which he said was such Bottles as Mr. Kenton likes for shape and Culler of Metal as soon as we received the patterns we indeavour'd to imetate the patterns for shape and Culler as nigh as possible. The Common Bottles are made of the same sort of Metal as the Champain Bottles is made of and I Believe the Common Bottles to be as Good Common's as ever was made at this place (N.C.R.O. 2DE 11/3/19, 25 January 1782).

There is absolutely no evidence to suggest that the "champagne" bottles were intended exclusively for champagne or that they had the long sloping shoulder and high bell-shaped pushups so characteristic of the 19th-century champagne-type bottles. The French champagnes listed in the 1787 Day Book probably resembled French forms of the period and may have been a precursor of the 19th-century champagne shape.

Other terms used by English bottlemakers in the second half of the 18th century related to size, shape, and possibly function. Corbyn, Winchester, rounds, and possibly olives were pharmaceutical shapes and the names, if not the shapes, continued in use into the 20th century (Crellin and Scott 1972: 10-14). Bottles for oil, olives, anchovies, pickles, snuff, mustard, fruit, gooseberries, and walnuts probably had distinctive, recognizable style variations. Pottle, scotch pint, and ale pint and quart were all size names. Surviving examples of dark green glass bottles exhibit a bewildering array of variations in body and shoulder shape, length of neck, and finish styles but it is difficult to link these forms with the documentary record (see McKearin and Wilson 1978: Figs. 44-47, 72, 75; Crellin and Scott 1972: Figs. 20-39; Noël Hume 1969: Figs. 32, 34, 35; Sands 1974: Figs. 1, 10).

The British glass industry had a brisk overseas trade for its products, attested to by the great quantities of British glassware found in North American archaeological contexts and mentioned in historical documents. The bottles were an integral part of this trade although their market value barely exceeded the cost of getting them to that market. In some instances it was not even worthwhile to ship them in packages or crates. In 1807 the Bristol glass manufacturers wrote that

> ...Our Objection to packing the Bottles solely arises from the rate of Freight upon such Packages whether in Baskets, Crates or otherwise being in many Cases double, and in some treble the Charge of stowing them loose, an increase Charge which the Goods will not admit of, therefore we must either ship the Bottles in Bulk or forego the Export of them altogether...
>
> The Plan hitherto adopted in the shipment is as follows: The

> Bottles exported from hence to Spain, Portugal and Ireland have been counted into Baskets, containing ten dozen each... and afterwards...stowed loose in the Vessels Holds in the same manner as Bricks and Tiles usually are...(Great Britain. P.R.O. *Customs 48* Vol. 46: 327-28).

Officials of the Leith Glass Company commented that the loose bottles were one of the last items stowed on board, and the order probably depended on there being room for them.

> I mention this because we have an order to-day to export bottles to the West Indies....Such orders are seldom given until the vessels are nearly ready to sail, bottles being the last thing stowed on board...(Great Britain...1835: 141).

Later in the century bottles were still shipped in this way:

> Glass Bottles, green or black, when laden in bulk on coal, the latter requires to be levelled as smoothly as possible, and the large knobs thrown fore and aft. Place a plentiful bed of straw on the coal and wedge the bottles so that they will not talk when the ship moves. The manufacturer sends an experienced hand to stow the bottles, and the master one of the crew into the lighter, as with earthernware. When empty bottles or bottled goods are packed with straw, it is highly necessary that before signing bills of lading the master should know that the straw is perfectly dry, or breakage will certainly ensue (Stevens 1871: 192).

Prices of bottles at the consumer level are difficult to assess. For most bottled products the cost of the bottles was simply included as part of the final package price and was not itemized separately. In other cases, however, especially when a merchant bottled a product on order, the bill included the cost of the bottles and sometimes the corks, shipping and labour. For example, in 1779 Sir William Erskine bought a pipe of old Madeira from the New York merchants Nicoll and Taylor for £100 and paid an additional £11 14s.- for 41 dozen and nine bottles and corks, nine empty casks and for bottling and packing (New-York Historical Society, Nicoll and Taylor Day Book, May 1777-Sept. 1779). Newspaper advertisements sometimes mention these additional charges:

> N.B. Two gallons of wine, or one gallon of brandy or rum, carriage free, to any part of the town, for ready money only, casks and bottles to be returned, or paid for (*The Gazetteer and New Daily Advocate* [London] 7 Nov. 1767: 2).

Reuse of bottles was commonplace. Merchants gave credit for returned bottles and offered to buy used bottles or to fill bottles supplied by the consumer:

> Any person who sends bottles and corks may have them carefully fitted and corked with beer and porter at 6s. or with ale at 4s. the dozen. I expect, in a little time, to have a constant supply of bottles and corks ... (quoted in Baron 1972 [1776, Virginia]: 62).
>
> ...At present the price of bottles...is such that it becomes a great

> object to dealers in wine to use the old bottles, and run the risk of tainting their wine in consequence of the price being as it is at present; were the price so low as it would be if the duty were removed, none but new bottles would be used, and the wine would not be injured (Great Britain...1835: 140).

Survival of quantities of old bottles in private cellars in England has been considerable. One of the best examples is the cellar at All Souls College in Oxford which in the late 1960s still contained over 1000 wine bottles dating from the mid-18th century to the mid-19th century (Haslam 1970: 27). In the 1950s a cache of 124 bottles, some of which contained wine, dating from ca. 1720 to 1840 was recovered in South Devon (Hughes 1955: 1575). I saw two bottles sealed Dally 1753 and four sealed C. or Cha. Pugh 1765 with John Pugh 1794 scratched on the shoulder. Reuse and long-term storage can make a significant difference between the manufacturing date for a bottle and the date it was deposited in the ground.

HOW THE ENGLISH GLASS "WINE" BOTTLE WAS USED

Specific beginning dates are difficult to establish but there is no doubt that the dark green glass "wine" bottle was used extensively for shipping, storing, maturing, and serving a variety of liquids. The most common were the alcoholic beverages, including wines, fortified wines, porter, ale (beer is used in this report as a generic term), cider, and distilled liquors (brandy, rum, gin, whiskey, arrack, and punches). Other types of products likely to have been sold in bottles of this size and shape, and for which some evidence exists, were vinegar, spa waters, and castor oil. The following discussion is based on British, Canadian, and American sources.

Shipping

Mathias (1959: 172) pointed out that some alcoholic beverages are bulky commodities and for economic reasons it was more advantageous to ship them in large containers than in small ones. As he states, trade in bottled beer represented only a tiny portion of what was manufactured and that much of the beer shipped out of England represented venture cargoes or orders sent as personal favours between friends and business associates. Nevertheless, a brisk trade in bottled alcohol existed in Britain and North America in the 18th and 19th centuries.

There is no doubt that the shipment of bottled products between friends and business associates was a regular practice. In the 1720s Robert Carter of Virginia wrote:

> "I am advised...nothing will contribute more to a cheerful clear temper than the use of Bristol waters. I would have (Mr. Gilmore) send me 1 dozen flasks or 2....I am grown so in love with the German Spaw that instead of 3 dozen bottles of it I desire you to let me have 6 dozen" (quoted in Noël Hume 1958a: 1056).

On several occasions the Norton family, merchants in Virginia, placed special orders for their personal use:

> P.S. Colo. Snelson & myself have an inclination to taste some good Burgundy & Champaign Wine, and therefore shall be obliged to you to purchase for me two dozen Bottles of each sort the best that can be had in London, and have it carefully packed and sent by the

> first of your Ships (Mason 1968: 189-90).

This type of order, however, was not without its hazards as is well illustrated by the complaints of the Langtons, a family who settled north of Peterborough, Ontario, in the 1830s.

> Our furniture has now all arrived except the sofa and two other packages, one a chest of drawers, and the other a case of wine. The latter perhaps they keep back to partake thereof, for a box containing a dozen bottles of Geneva has been considerably robbed, two whole bottles taken and two or three half-emptied. Some wine has likewise been equally ill-treated (Langton 1964: 36-37).

Commercial use of bottles for shipping had begun in the second half of the 17th century. During the 1670s a brewery in Leith had an interest in a bottle-glass factory whose main products were apparently bottles for the brewing trade (Donnachie 1979: 4-6). In 1698 bottle manufacturers at Gloucester and Stourbridge complained that the recently imposed excise duty had raised the price of bottles so high that their customers were putting cider into casks instead of bottles (Buckley 1929: 127). It was the government's view that

> The Demand for Bottles indeed at Gloucester and Sturbridge may have been less than usual: But the want of Cyder, not the Duty, has been the Occasion of that, together with the vast Quantity they made before the Act took place: for 'tis known they have had no Cyder for Two Years past, on which the Bottle-Trade in those Parts depends... (quoted in Buckley 1914: 61).

The association between brewers, makers of cider and glass bottle manufacturers was also a feature of the Bristol export trade from the 1770s until ca. 1820 (Mathias 1959: 194). For example, the following advertisement appeared in *Felix Farley's Bristol Journal*, 2 Aug. 1788:

> John Robert Lucas, intending to confine himself solely to the Crown Glass and Glass Bottle Manufactures wishes to dispose of the Beer and Cyder business which he has many years carried on in Nicolas Street (quoted in Buckley 1925: 55).

Jacob Wilcox Ricketts, a partner in the Phoenix Glass Works had been one of the founders of the Bristol Porter Brewery in 1789. The family connection with brewing continued through the first half of the 19th century (Alford 1968: 13; Powell 1926: 236 n.; Bush 1976: 131, 243).

By the late 17th century bottled beers, wines, and other liquors were being shipped as far as India. For example, the *Rising Sun* sailed from Greenwich to India in 1703-4 carrying more than 5000 bottles of liquor, including 2500 bottles of beer. The bottles were packed in chests complete with locks and hinges (Noël Hume 1961: 111-12; Francis 1972: 144-45). In 1705 Bristol merchants successfully petitioned for the removal of an import duty of 2s. 6p. per dozen bottles of beer imposed by the Government of Jamaica (Mathias 1959: 193 n.3). Although casks were used for the bulk of the overseas trade, bottled English and Scottish porters and ales, Hereford cider, and assorted wines appeared regularly in North American newspaper advertisements. Many of these goods had obviously arrived already bottled. Nor was the shipping trade confined to Britain. American beers were also bottled for shipping. For example, Benjamin Williams advertised in the *New York Gazette and the Weekly Mercury*, 23 May 1774 that

> he intends carrying on the business of bottling beer as usual. Repeated trials have prov'd it will stand the West-Indies. Captains of vessels may be supplied with what quantity they please, on the shortest notice, at ten shillings per dozen; gentlemen in town (for present use) on the same terms, or seven shillings, if they return the bottles.
>
> N.B. Fine cyder of a peculiar quality and flavour, per dozen as above. A good price will be given for empty quart bottles (quoted in Gottesman 1970: 290-91).

The distilled liquors, however, appear to have been bottled at, or close to, the retail level. In Canadian newspaper advertisements between 1774 and 1784, very few references to bottled liquors appear while numerous instances of wines, beers, and ciders being offered in bottles have been found (Sullivan 1982a, 1982b). On the other hand, local merchants, such as Samuel Sherwood on the Bay of Quinte, regularly sold both whiskey and rum by the bottle, half-pint, pint, quart, and gallon (Burleigh 1975). The problem of bulk in relation to value, so common with alcoholic drinks, can be lessened with the distilled liquors as they can be shipped at high proof and then watered down when sold at the consumer level (Great Britain...1833: 30, 35).

Bottled liquors were shipped or sold in chests (Noël Hume 1961: 111-12), hampers (*Quebec Gazette*, 9 July 1778: 3), casks, and cases of various sizes. For example, William Abbot of Halifax offered:

> Herefordshire Cyder 7 Dozen, in Cases, Best London Bottle Porter in Casks, from Five to Fifteen Dozen, Best Dorchester Beer in Casks of Four dozen each (*Nova-Scotia Gazette and the Weekly Chronicle* 23 May 1780: 4).

In the following year Louis Marchand of Quebec offered claret in cases of four dozen, and French brandy, white wine (vin de Grave), and best Holland's gin in 12-bottle cases (*Quebec Gazette*, 11 Oct. 1781: 3).

Storing and Maturing

Extensive use of glass bottles to store such items as wine, beer, and cider probably began in the second half of the 17th century. Worlidge, in his book *Treatise of Cider* published in 1676, recommended that glass bottles be used instead of stoneware ones, and that the bottles be laid on their sides to keep the cork closures wet or that they be placed upside down in frames. Some cellars still have shelves with holes in them which would have been suitable for storing bottles upside down (McKearin and Wilson 1978: 213-14). Pepys described the wine cellar of Mr. Powys, which he saw in early 1663:

> But still, above all things, he bid me go down into his wine-cellar, where upon several shelves there stood bottles of all sorts of wine, new and old, with labells pasted upon each bottle, and in that order and plenty as I never saw books in a bookseller's shop (Latham and Matthews 1971: 18).

Between 1670 and 1692 the earl of Bedford purchased a minimum of 1070 dozen glass quart bottles and 290 dozen stoneware quart bottles (Thorpe 1938: 201), quantities sufficiently large to suggest that the bottles were being used for storage. Throughout the 18th and 19th centuries inns, taverns, institutions, organizations, merchants, and private individuals stored assorted bottled liquors on their premises, the amount varying considerably. The 1717 inventory of Jean Morot's tavern in Williamsburg, Virginia, included 621 bottles of wine, 62 bottles of brandy, and 57 bottles of English beer (Noël Hume 1957a: 450). Sir Robert Walpole, a free-spending official in the English government, entertained lavishly. In 1733 alone he returned 552 dozen empty bottles to his wine merchant and this did not include the wines that were drawn directly off the cask (Plumb 1963: 158, 168). Lord Botetourt, governor of Virginia, had nearly 2700 bottles of liquor in his possession at the time of his death in 1770, but his entertaining responsibilities were significant; on some occasions he had as many as 52 guests for dinner (Noël Hume 1957b: 764). An advertisement for the sale of the effects of a bankrupt included:

> FIVE Pipes and six Dozen of fine old Madeira Wine, five Pipes and fourteen Dozen of Red Port, three Pipes one Quarter Cask and fourteen Dozen of Lisbon, one Ullage of White Port, two Butts one Hogshead and five Dozen of old Mountain, two Hogshead and eleven Dozen of Sherry, one Ullage Hogshead of Spanish Wines, 20 Gallons of Rum, 21 Gallons of Brandy, some empty Casks and Scantlings, in Vaults under Mr. Delamotie's in Great St. Helen's Bishopsgate Street *(The Gazetteer and London Daily Advertiser* 9 Nov. 1762: 3).

The effects from Major-General Brock's estate, sold in 1812, included 566 bottles of port, 48 bottles of claret, 45 bottles of sweet wine, 10 bottles of champagne, 24 bottles of Quebec ale, 15 bottles of porter, two bottles of brandy, and 12 bottles of shrub (a type of punch sometimes sold commercially) (Metropolitan Toronto Library...). Wine merchants, in giving evidence to the Commissioners of Enquiry in 1833, noted the large quantities of bottled wines they had in stock. One witness stated: "I have seen piles of wine as deep as this room" (Great Britain...1833: 77). Another merchant noted that

> there is always an immense stock kept of wine. I should say in the dealer's stock, there is three or four years' consumption of Port

> wine, because it requires a long time in bottle to get it fit for use (Great Britain...1833: 44).

On the other hand, spirits merchants tended not to keep their stock in bottles (Great Britain 1833: 43; 1834: 365).

Certain products, primarily wine, fortified wines, and cider can be improved in the bottle. Even as early as the 1630s the East India Company had noticed that cider should be matured for a year before it was drunk (Francis 1972: 149). Worlidge, in his treatise on cider, recommended storing bottled cider in spring water, either running or changed frequently, where it could "come to the strength even of Canary it self" (McKearin and Wilson 1978: 214). Writing in the early 19th century Rees (1819: Vol. 10, Cyder) noted that "Cyder is generally in the best state to be put into the bottle at two years old, where it will soon become brisk and sparkling...."

Storing wine in bottles to mature is done both for vintage wines and fortified wines. The fortified wines (i.e. port, sherry, Madeira, Marsala, Malaga) are wines to which brandy has been added. This was probably done originally to keep the wine from spoiling as brandy raises the alcoholic content to a point where fermentation cannot continue. Some types are aged in casks, some in bottles (Marrison 1962: 111-36). The practice of fortifying wines increased steadily as the 18th century progressed. For example, as early as 1720 the addition of brandy to port was recommended, and by the 1740s was widely done. The results were variable. By the beginning of the 19th century the average maturation period for port in the bottle had reached three years (Francis 1972: 227-29, 232-34, 237-45, 260). Period newspaper advertisements sometimes mentioned the vintage year or the number of years the wine had been in the bottle but more often used adjectives such as choice, old, fine old, very old, and so on (Schalch 1966: 1478; Sullivan 1982a, 1982b).

> About fifty dozen of rich, high flavoured Madeira wine that has been 10 years in bottle; 15 dozen of fine old port, bottled in the year 1803; and about 22 dozen of claret, bottled at the same time...(*The Times* [London] 10 Dec. 1807: 4).

Between 1810 and the late 1860s, when the *phylloxera* disease began devastating the European vineyards, many consider that vintage wines and matured fortified wines were at their peak of production and perfection (Francis 1972: 311-12).

Bottles for long-term storing and maturing purposes needed to be chosen carefully and cleaned thoroughly before being filled. Directions for home bottling included the following instructions:

> Bottles should be selected of good manufacture, and of equal diameter throughout, or they will be liable to break in the bin when piled vey high...Twenty-four hours, at least, before they are filled, they should be cleaned and rinsed. Lead shot is commonly employed for cleaning them; but it is desirable that great care should be employed that none are left in the bottles, as sometimes happens; one or two grains of shot not unfrequently remain in the

> bottle jammed in the angle, and if these should be dissolved by the acid of the wine they will communicate to it a poisonous quality. It would be very easy to procure small, round pebble stones of the size of shot, which would answer the purpose quite as well. Sand or angular pebbles will scratch the bottles.
>
> Bottles are best if quite new; but if thoroughly cleaned they will continue to answer sufficiently (Webster, Parkes, Reese 1845: 649).

Occasionally bottles from archaeological contexts have small shot wedged in the space between the body and the pushup.

Once the products are in the bottles they still require care and attention. In 1767 the Scottish brewers Joseph and William Cunningham and Co. gave advice on clearing and storing beer shipped to North America.

> DIRECTIONS for managing STRONG BEER, exported to *America*, &c. It sometimes happens, that Strong Beer (tho' perfectly fine when bottled) by the effect the different climates it goes through has on it, throws up. If this is the case when it arrives in North America, or the West-Indies; the purchaser will please unpack it, and set the bottles in any warm place on their bottom, and it will fine down in a few days. The warmer the place be, the better. — In cold Climates, Strong Beer will always throw up; and therefore should be kept in warm cellars. From South Carolina to the Northward, all Strong Beer must be kept in cellars, during the Winter, where no Frost can enter. — From that to the Southward, the Beer needs no management, further than the natural heat of the climate (quoted in Baron 1972: 59n).

Cider was particularly difficult to manage as it was generally sparkling and tended to burst bottles. Henry Purefoy described this problem graphically in 1736:

> ...I desire you will send my mother 8 gallons of Canary in a runlet, she desires of all things it may not be on the fret, for the last you sent was like bottled Cyder and flew all about ye Cellar and broke ye Bottles (quoted in Davis 1966: 226).

Rees (1819: Vol. 5, Bottling) recommended that if one bottle in a group burst, it was wise to uncork all the bottles, let them sit uncorked for two or three days and then recork them.

The "Wine" Bottle as Serving Bottle

Written evidence for the use of the "wine" bottle at the table has been difficult to find as one can never be sure whether the term "bottle" refers to the dark green glass container or the colourless tableware decanter. Pepys mentions being served wine in bottles in the 1660s

(Latham and Matthews 1970: Vol. 1, 39, 68-69, 98, 113). From 1660 to ca. 1750 Oxford taverns supplied bottled wine to All Souls College, often in sealed bottles used as serving bottles (Haslam 1969: 51, 58). The Honourable John Bing, in his travels through the Midlands, the south of England, and Wales between 1770 and 1790 was served bottles of wine, almost invariably port, in the inns where he stayed (Francis 1972: 232-35, 242-43). A rather disparaging comment describes New Orleans in 1801:

> Red wine is the order of the day, which from the difficulty attending commerce with France, is but very indifferent — as to Madeira it is little used & without much credit as to quality or neatness — drunk out of black bottles & tumblers to me however good, it appears execrable (Wilson 1973: 877).

In the 1840s Susanna Moodie and her family, settling in Ontario, encountered their first "*genuine* Yankee":

> 'Them strangers are cum; I'll go and look arter them.' 'Yes,' says he, 'do — and take the decanter along. May be they'll want one to put their whiskey in.' 'I'm goin' to,' says I; so I cum across with it, an' here it is. But, mind — don't break it — 'tis the only one we have to hum; and father says 'tis so mean to drink out of green glass' (Moodie 1962: 71).

Iconographic evidence for the use of the "wine" bottle as a serving bottle is plentiful although it is difficult to know what was in the bottle. Generally the paintings and prints depict scenes of an informal nature, usually only men, and when women are present they are obviously of a lower class than the men. Occasional exceptions can be found, however, as in the case of an "informal" musical supper of unquestionable gentility given by the Prince de Conti in the mid-18th century. Between each couple is placed a cellaret holding two dark green glass bottles, of a French shape, from which the gentlemen pour the drink into their female companions' glasses (reproduced in Willan 1977: 80-81). A slightly later Dutch painting also shows a sedate meal in mixed company with a dark green glass bottle on the table (McNulty 1971: Fig. 58).

Picnics were occasions, with mixed company of the same class, when there were plenty of "wine" bottles. Van Loo's "Un déjeuner de chasse" 1737 has both dark green glass bottles and a colourless or transparent one of the same size on the tablecloth (Barrelet 1957: Fig. 6). Two picnics depicted by James Cockburn at Horseshoe Falls, Niagara, 1831 (Fig. 1) and at Montmorency Falls in 1836 included dark green glass "wine" bottles. A mid-19th-century American painting of a picnic held in Camden, Maine, shows a large family gathering around a laden table which also bears what appears to be champagne bottles (Younger 1966: 455). Mrs. Beeton's picnic for 40 persons included the following beverages:

> — 3 dozen quart bottles of ale, packed in hampers; ginger-beer, soda-water, and lemonade, of each 2 dozen bottles; 6 bottles of sherry, 6 bottles of claret, champagne à discrétion, and any other light wine that may be preferred, and 2 bottles of brandy. Water

> can usually be obtained so it is useless to take it (Beeton 1968 [1861]: 960).

Convivial groups of gentlemen were more commonly depicted, however, as in Hogarth's "Midnight Modern Conversation" (Younger 1966: 338). In "Peter Manigault and His Friends" by George Roupell, eight men seated around a table in Charleston, South Carolina, ca. 1760 have in front of them a punch bowl, four dark green glass bottles, two decanters, 11 stemware glasses (one broken), and two candlesticks. A slightly larger group

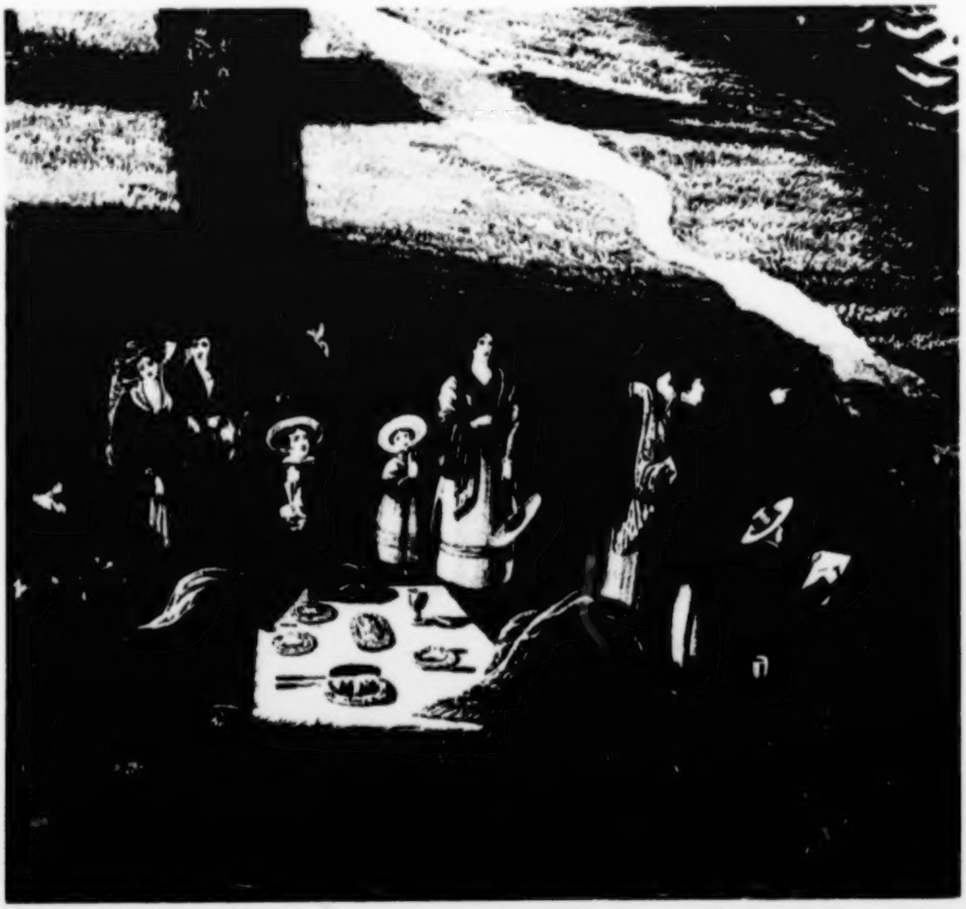


Figure 1. Picnic on Goat Island at Niagara Falls shows hampers and other picnic necessities including "wine" bottles. (James P. Cockburn, engraved by C. Hunt, 1833. Public Archives of Canada, Picture Division, Ottawa)

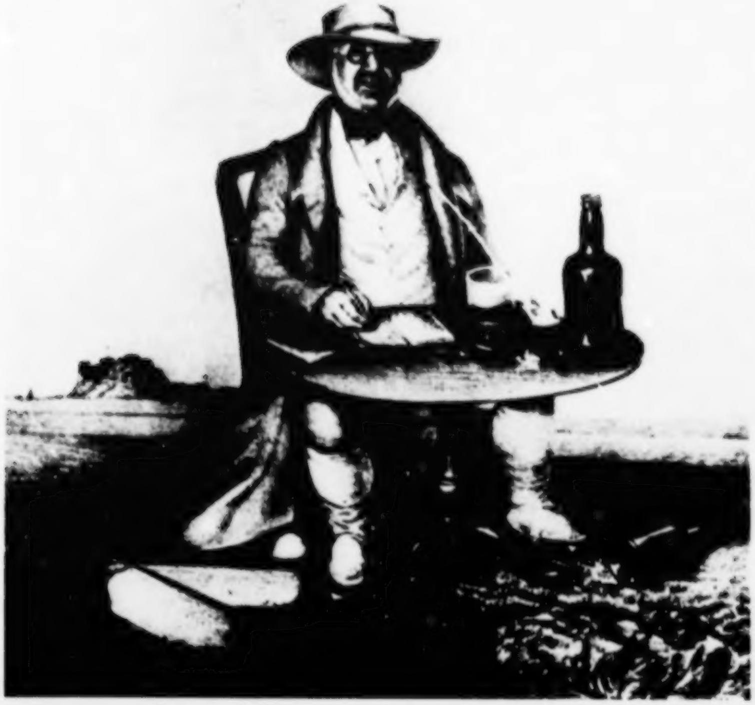


Figure 2. William Davies of Brighton, scoring a cricket match, beer-style bottle on the table in front of him. The bottle dates considerably earlier than the print. (Thomas Henwood, 1842. Courtesy Marylebone Cricket Club, London)

painted by Henry Sargent ca. 1820 sit formally around a table, again with wine bottles and decanters on the table, a fresh supply of decanters on a side table and bottles in a case under it and a cellaret on the other side of the table (Peterson 1971: Plates 4, 30). Two French paintings of the 1730s, "The Oyster Party" by de Troy and "The Luncheon Party" by Lancret, both show a rowdy group of gentlemen serving themselves directly from "wine" bottles, of which there are plenty available (Oliver 1967: 168, 238).

One did not need company to use the "wine" bottle as a serving bottle (Fig. 2). The French artist Alexis Grimou (1678-1733) painted himself smiling with a "wine" bottle and drinking glass in front of him (McKearin 1971: Fig. 8). Two or three gentlemen were able to enjoy themselves, with the "wine" bottle sitting between them (Younger 1966: 336, 353, facing page 384). "Wine" bottles were also used on tables in public drinking and eating places such as inns and cafés, again often accompanied by some type of colourless bottles (Oliver 1967: 247, 248, 251; Younger 1966: 374, 376, 410).

There is no doubt that the dark green glass "wine" bottle was used throughout the 18th and 19th centuries as a serving bottle within certain social contexts. Its presence on many tables in conjunction with colourless decanters gives rise to questions about what was being drunk with what.

CLOSURES

For a bottle to be an efficient storage and shipping container it has to be properly closed. One of the best closures is cork. Made from the bark of the cork tree, cork can be compressed and will return to its former shape when the pressure is released. Forced into the neck of a bottle, the cork presses against the inner bottle surface and as long as it is kept moist will stay in this position and will allow only a very slow evaporation of the bottle's contents. The usual method is to store the bottles on their sides, or, as was apparently the case in the late 17th century, upside down in shelves with holes in them. Dry corks shrink, allowing air to get into the container. The use of cork as a closure was known by the 16th century but appears to have become widely used in the 17th century along with the increasing use of glass bottles (McKearin 1971: 120-27; Noël Hume 1961: 110-12).

For storage, corks are held in place by being tied down. A description published between 1613 and 1631 records the use of pack thread (McKearin and Wilson 1978: 212). Copper alloy wires were in use by the early years of the 18th century and were used continuously after that until interest in other forms of closures developed in the second half of the 19th century. Examples from archaeological contexts show a single strand of wire twisted so that it crosses over the cork twice in a V-shaped loop (Fig. 3). More than 20 examples from the *Machault*, a ship sunk in 1760, exhibited no signs of having any type of covering over the cork and the wire (Sullivan 1979). Several other archaeological examples, dating from ca. 1790 to 1850, also have only the cork and wire present. These same examples show clearly that the cork was not always driven flush, as is popularly believed (McKearin 1971: 125), but that they sometimes extended slightly above the lip (see also Noël Hume 1958b: 776).

Several references, however, suggest that the corks were sometimes covered. An early example, a wine bottle dating to 1727, is reported to have the cork covered with wax and cloth and held down by a string attached under the string rim (Noël Hume 1958b: 774, 776). The use of parchment, paper, and bladders, sometimes impregnated with other substances such as wax or resin, to cover mouths of bottles and jars was common in the 18th century particularly for home bottling (McKearin and Wilson 1978: 249-52). For bottling cider Rees recommended that

> ...the corks be driven very tightly into the necks of the bottles, tied down with small strong twine or wire, and well secured with melted rosin, or other material of the same nature...(Rees 1819: Vol. 10, Cyder).

Bottled spa waters from Spa, Pyrmont, Scarborough, and other places had to be well-bottled and corked to preserve their taste and smell.

> To preserve them, it is necessary the bottles be filled up to the mouth, that all the air may be excluded, which is the great enemy of bottled liquors. The cork is also farther secured by cement (Rees 1819: Vol. 5, Bottling).

Directions on home bottling mention corks and sealing them with a type of "cement."

> Fill the bottle to within two inches of the top of the neck, so that, when the cork comes in, there may remain three quarters of an inch of space between the wine and the lower end of the cork. ...If the cork is to be waxed, it must be cut off close, or to less than a quarter of an inch. Champagne bottles sometimes have their corks driven but half way, and are fixed down by a wire; this makes them easy to draw. It is best to cut off the cork close to the glass, and to cover the whole top with cement, to prevent the air from passing between that and the corks. Insects also abound in some cellars, which eat through the corks....
>
> For the cement, resin, with half the quantity of Burgundy pitch, and a fourth of bees' wax, with a small portion of any colouring substance, is used by the French manufacturers; or, melt carefully together a pound of resin, one of bees' wax, and half a pound of tallow, and keep stirring all the while. Add to this red or yellow ochre, soot, or whiting, according to the colour required...The end of the bottle-necks are dipped into this mixture melted (Webster, Parkes, Reese 1845: 649).

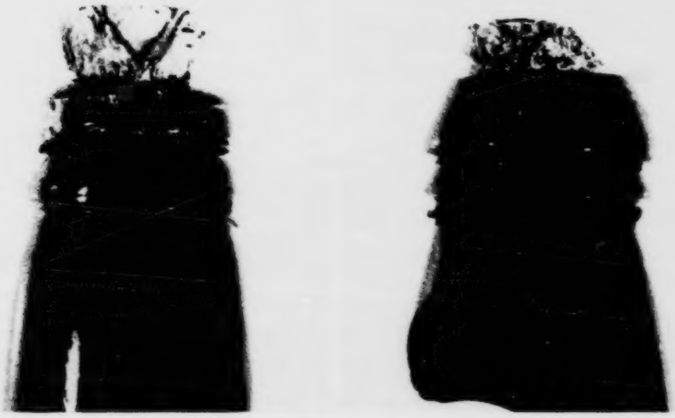


Figure 3. In these archaeological examples with fully developed lips, the wire is fastened either under the string rim or under the lip. Cork extends considerably above both lips. (Photos by R. Chan; RA-5896, RA-5936B)

DEVELOPING A CHRONOLOGY FOR CYLINDRICAL ENGLISH "WINE" BOTTLES

It is possible to develop a chronology for the English "wine" bottle for two reasons. First, there is no doubt that the bottle shape was changed through time. The reasons for this change are not clear but even after the introduction of the cylindrical form, the bottle still went through changes in proportion, and in the shape and size of the finish, neck, and basal area. Certain of these changes can be linked to changing technology but others appear to have been related to a desire to change the appearance of the bottle. Second, until the early 19th century the development of the English "wine" bottle style appears to have been independent of European bottle styles. The latter have generally received scant attention from researchers but the products of Belgian factories (Chambon 1955: Pl.T), Dutch factories (McNulty 1971), and French factories (Alyluia 1981: 22-60; Harris 1979; Ducasse 1970: 396-99) show distinct stylistic differences from British bottles. By the second quarter of the 19th century, however, American glassmakers were making "wine" bottles in the English style. At least one bottle (Appendix A, No. 207) used in this study, embossed DYOTTVILLE GLASS WORKS PHIL^{A}, is a direct imitation of the Ricketts' mould bottles (illustrated in McKearin 1970: Pl.9, Fig. 1). I may have used other American bottles but they cannot be distinguished from their British counterparts.

The measurements and attributes recorded for this study were based on the differences observed on bottles from six Canadian sites with overlapping periods of occupation between ca. 1760 and 1850 and on published studies of wine bottles. I felt that the actual measurements could be used not only as dating guides but also as objective criteria for defining subjective descriptive terms such as tall, short, narrow, wide, and tapered. The attributes chosen seemed to reflect datable size, stylistic, and manufacturing changes. Because the bottles could not be examined together, I described each bottle in detail (i.e. shape of individual features, evidences of manufacturing techniques), photographed the overall bottle and details of the finish area, and took up to 20 measurements on each bottle.

To determine the chronological development of the changes in shape, size, and technology of the cylindrical dark green glass English "wine" bottles, I used the traditional approach. I examined 211 sealed and dated examples, dated between 1737 and 1858, in private and museum collections (Fig. 4). Not all decades were equally represented (Table 1). Some seals were duplicates and the bottles bearing duplicate seals were considered to

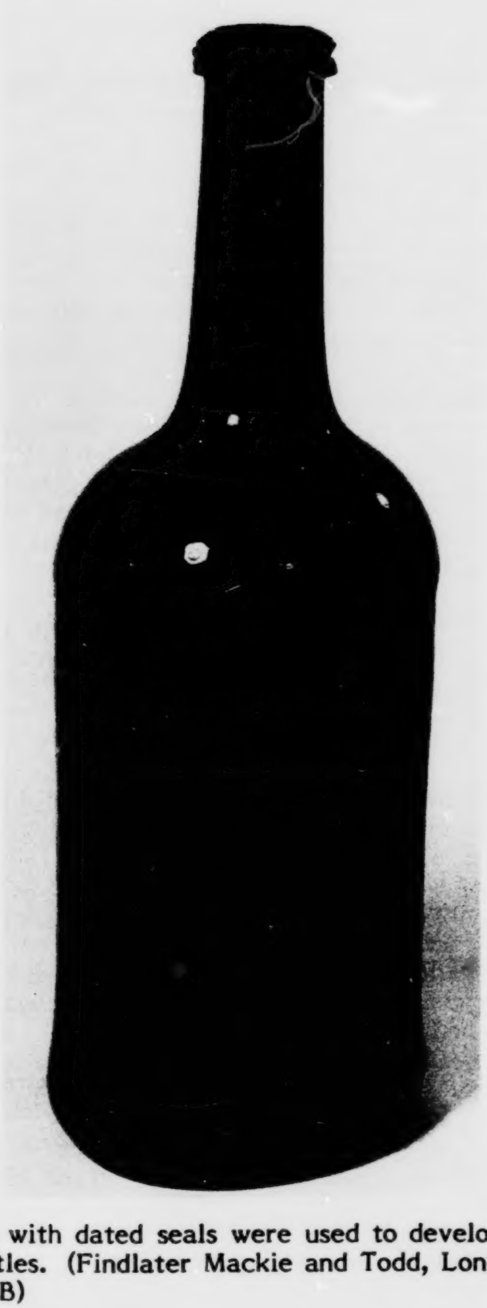


Figure 4. Bottles with dated seals were used to develop a chronology of English "wine" bottles. (Findlater Mackie and Todd, London. Photo by K. Praeter; RA-12769B)

Table 1. Total number of dated bottles per decade, all sizes

	Gallon	2-Quart	Quart	Pint	1/2 Pint	Total
1737-39	-	-	5	-	-	5
1740-49	-	-	4	1	-	5
1750-59	-	1	9	2	-	12
1760-69	-	3	23	2	-	28
1770-79	-	-	36	-	-	36
1780-89	2	1	29	1	-	33
1790-99	-	1	30	1	2	34
1800-09	-	1	17	-	-	18
1810-19	-	-	14	-	-	14
1820-29	-	3	13	-	-	16
1830-39	-	-	5	1	-	6
1840-49	-	-	3	-	-	3
1850-59	-	1	-	-	-	1
Total	2	11	188	8	2	211

have been manufactured in the same factory at virtually the same time. Consequently they were not considered to have the same value as bottles with seals that occurred only once. For the statistical analysis a weighting factor was assigned to the bottles, based on the number of examples of each seal (Appendix A). However, the presence or absence of the weighting factor had little effect on the results of the statistical analysis (Cohen 1984: pers. com.).

The dates on the seals do not always correspond to the year in which the bottle was made. The date could represent a vintage year, an anniversary, or some other event. Probably the most startling examples of the date on the seal bearing no relation to the date of manufacture is a group of bottles sealed W. LEMAN CHARD 1771. The bottles were blown in a Ricketts' mould patented in 1821 and must date after 1821 (Jones 1983).

Because of the potential unreliability of the dated seals I felt that many bottles had to be examined to arrive at valid conclusions for the changes in the various aspects of the bottles. It has not been possible to entirely satisfy this requirement because of the duplication of seals, the limited number of dated seals in certain decades, the variation in capacity, and the difficulty of finding large collections of bottles in one place. However, I found that occasional examples that were obviously manufactured at a much later date than that on their seals could be easily identified (e.g. Appendix A, Nos. 51, 149). Normally the different characteristic dating features did tend to cluster around certain periods.

At the beginning of the study, I assumed that all bottles of the "quart" size were probably about 26 ounces (±750 mL), the standard wine bottle size. However, partway through the study I measured a group of bottles at the Corning Museum of Glass for capacity and found that the "quart" capacities varied so markedly that certain variations in the base and body diameters, and in the body and bottle heights were more likely related to capacity than to date of manufacture. After this I measured the capacity of individual bottles when possible. Of the 211 dated examples, 127 were measured for capacity, 110 of them "quarts." To compensate for the limited number of possible size and capacity correlations in the dated group, I measured and described a second group of bottles, consisting of 127 examples of complete undated bottles of similar types. These were from private collections and archaeological contexts in North America.

It was my intention to use groups of bottles from dated and/or sealed archaeological contexts in Environment Canada - Park's collection to test the results of the statistical and formal analysis. Published site reports (Sands 1974; Brown 1971) were less useful for measurement comparisons as the data were not always comparable with those used in this study.

To understand and date the changing technology apparent in the bottles, I made observations on the dated bottles and consulted the literature on glass manufacture, such as encyclopaedias and technical books (e.g. Pellatt 1968; Bontemps 1868) and official documents relating to the British glass industry. Generally these documents were less useful than I had hoped.

FINISHES AND NECKS

Finishes

The finish consists of the lip, string rim, and bore (Fig. 5). From the mid-17th century until the 1760s the "wine" bottle finish was a relatively constant feature, consisting of a cracked-off or fire-polished lip and a string rim. Formed by adding glass to the neck (Fig. 6), the string rim was the dominant feature of the finish, accounting for over half the total finish height. In the 1760s, however, additional tooling of the lip began to be done. At first only the crack-off surface was tooled, slightly altering the thickness of the glass and the shape of the lip. By the end of the 18th century the lip was being more extensively tooled and glass began to be added onto the neck not only to make the string rim but also to make the lip. After the 1820s the lip was always formed from added glass.

As more and more attention was paid to the lip, it became wider and taller, causing a gradual increase in the total finish height. The string rim, on the other hand, remained relatively constant in size. As a result, the lip gradually became the dominant feature of the finish. From the 1820s onward the string rim was generally less than a third and frequently less than a quarter of the total finish height.

There does not seem to have been any practical reason for the change in the lip. The string rim provided a suitable ledge for attaching the wire or thread used to hold down the cork and still serves this function on French champagne bottles. On bottles with fully developed lips the wire will sometimes appear under the lip and sometimes under the string rim (Fig. 3). The additional work on the lip represented additional time spent making the bottles and added to the cost of manufacture. The gradual change in the lip appears to have been caused by a desire to change its appearance and not for any practical reason.

While the transformation of the finish contributes significantly to the development of a chronology for the English glass "wine" bottle of the ca. 1735-1850 period, it is not an easy feature to systematize. First, the finish on the quart-size bottles was, before the 1820s, seldom more than 20 mm high. The change in lip height, therefore, operated within a very narrow margin; a difference of five mm could have a significant effect on the overall appearance of the finish. Second, before the introduction of the finish-forming tool in the 1820s, the finishes were formed by tools that did not rigidly control the size and shape of the individual elements. As a result, the lip or string rim frequently varied from one side of the finish to

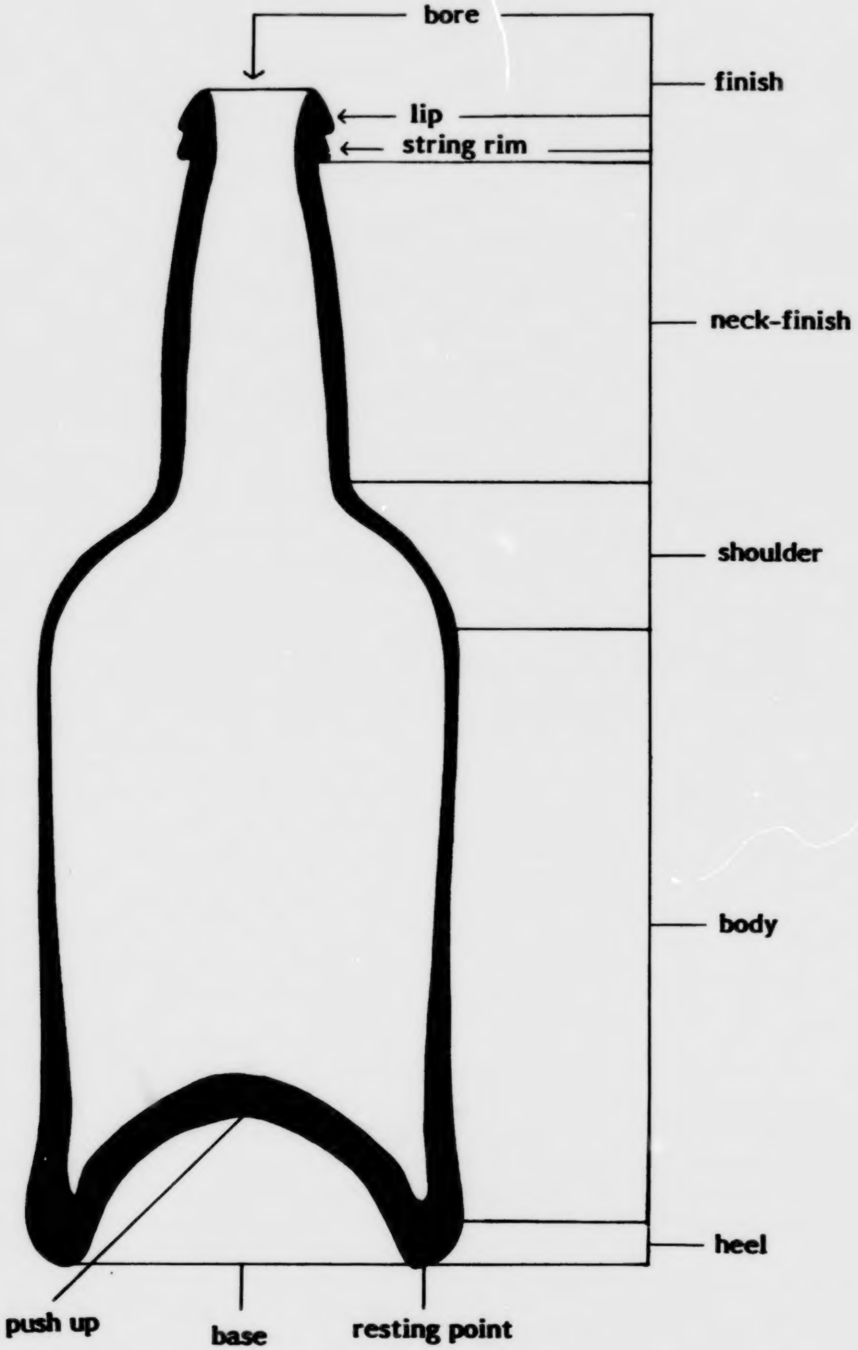

bore
finish
lip
string rim
neck-finish
shoulder
body
heel
push up
base
resting point

Figure 5. Bottle anatomy.

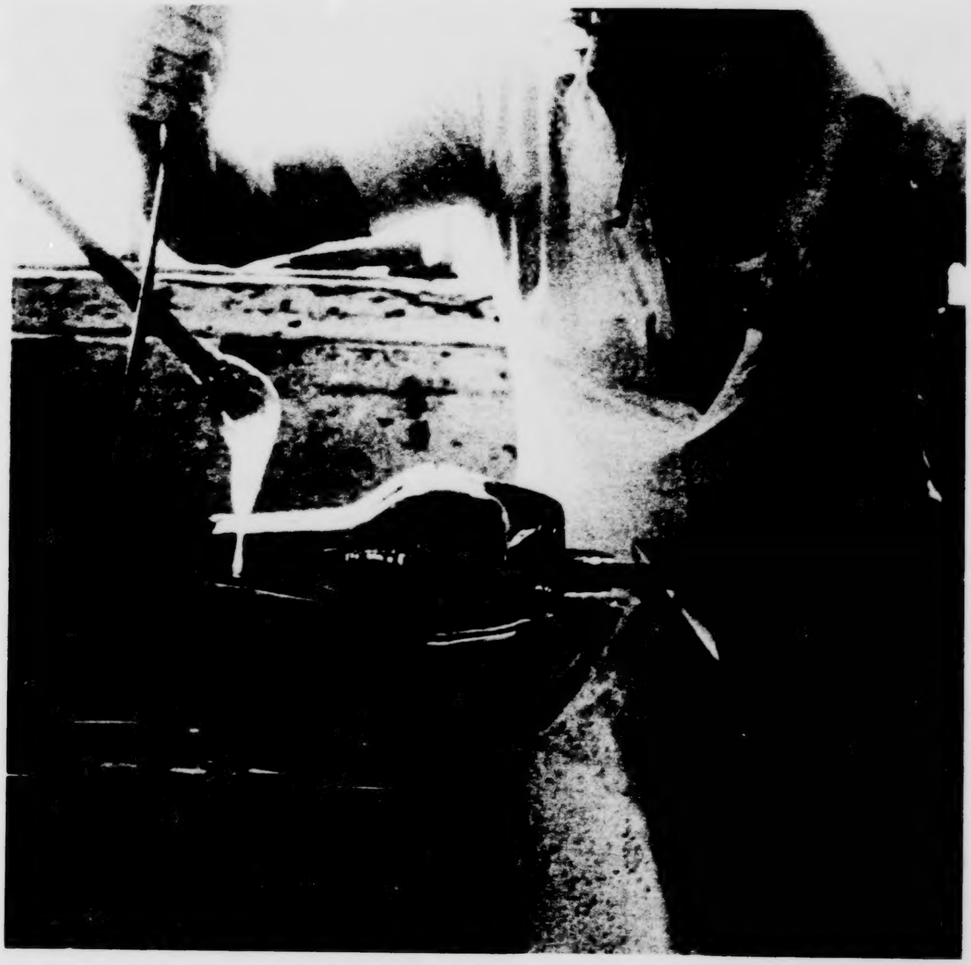


Figure 6. Thin stream of glass is added to the bottle neck to form a string rim. (Chalet Glassworks, Cornwall, Ontario. Photo by O. Jones; RA-3603M)

the other (Figs. 22b, 45, 48), making the "real" or intended shape or size difficult to determine. When more than half the lip or string rim seemed to be of one size or shape this was generally assumed to be what the bottlemaker had intended to make. In other cases, for example differentiating between an "unthickened" or a "slightly thickened" lip, the lip in question was compared with other lips that clearly belonged in each category. In taking measurements (see Measurements) often a mid-point was used. The finish height (see Appendix A) is frequently greater or smaller than the combined lip and string rims heights, partly because of gaps between the two features, partly because of the use of mid-point measurements, and partly because what appeared to be the intentional lip height was located in a different place on the circumference of the finish from what appeared to be the intentional string rim height. Each feature was measured independently from the others.

Finally, it was extremely difficult to develop terms and concepts that could be objectively defined, that could be maintained on a strict basis for the sample studied, and that other researchers would have no difficulty in recognizing. To solve this problem I made up to 11 observations for shape and manufacturing process on the finish area alone, but satisfying all three criteria all the time has proved to be impossible. For example, a distinction was made between the down-sloped lip (Figs. 22-26) and the down-tooled lip (Figs. 41-47). Although either term could be used to describe the shape, and in some cases the technique of manufacture, it was clear when one examined the general trends of the lip development that down-sloped and down-tooled lips represented different styles and, to a certain extent, different time periods. Also, I could not establish objective criteria for distinguishing between unthickened cracked-off lips and lips that were slightly thickened. If measured, the thickness of the slightly thickened lip and the neck may actually be the same on many examples. Nevertheless, on most examples the term is useful to describe the visual impression of a deliberate, if slight, widening of the crack-off surface. Distinguishing between these two types of lips is key to using the dating formulas (see Measurements) but no doubt other researchers will sometimes find it as difficult as I do.

In spite of these difficulties there are observable and measurable changes in the finishes of the "wine" bottles between 1735 and 1850. Individual finishes may sometimes be difficult to categorize but general trends or groupings can be established for material from archaeological contexts.

Lip

When the dark green glass "wine" bottle was developed in the mid-17th century the finish was formed by cracking-off the lip and by adding a rough trail of glass around the neck just below the lip to form the string rim. A glass object is cracked-off from the blowpipe by creating local thermal stress in the glass at the desired point, usually by touching the glass with a moist or cold tool and then giving the blowpipe a sharp tap. This action detaches the object at the point of stress. The crack-off surface is flat, but not necessarily even, and has sharply defined edges

(Figs. 15, 18). A slight reheating of this surface will smooth the edges and other irregularities (Fig. 17). This type of lip on the English wine bottles continued to be produced as late as 1780. A variation of the cracked-off lip occurred on the cylindrical bottles between ca. 1760 and 1785. A slight widening of the bore caused the crack-off surface to slope down, giving the lip a V-shaped profile (Figs. 19, 20). No widening or thickening of the lip itself was done.

In the early 1760s the lip began to be widened or "thickened" slightly by tooling and/or heating the crack-off surface. The lips were not formed by adding glass, as has been suggested by Haslam (1970: Fig. 10, and Plate IX, Nos. 6-8) and Dumbrell (1983: 38-39, examples dated 1750-70, 1770 [2]). The most common shapes were a sloped-top lip (Figs. 22-26), a flat-topped lip (Figs. 27-31), and a V-shaped lip (Figs. 32-37). All of them give the impression of being slightly thicker than the glass in the neck. The V-shaped lip and sloped-top lip are basically the same type but derive their differences in shape from the different placement and shape of the string rim. This style lasted until 1800.

Between 1784-85 and 1790 a new style and technique of lip formation began to emerge. In these lips the upper slope of the lip is longer than the underslope of the lip, giving this type a down-tooled or flattened profile (Figs. 41-49). In some examples there is a distinct separation between the lip and string rim (Fig. 48) whereas in others the upper edge of the string rim is adjacent to the under side of the lip (Fig. 43). The lips were formed in three ways: by extensive tooling of the glass at the end of the neck (Figs. 7-8, 45), by adding a wide band of glass that was then tooled to form the lip and string rim (Fig. 40), and by adding a double spiral of glass to form the lip and string rim (Figs. 43, 51). All three techniques appear to have been introduced about the same time although the wide band technique may be slightly earlier. Two bottles dated 1778 and 1780 may be examples of this technique but the lips are so poorly formed it was difficult to be sure the results were intentional.

It was frequently impossible to determine which technique had been used on individual bottles. In some cases the lines of addition could be clearly seen (Figs. 41, 44, 49, 51). In others, lines and striations on the neck carried through under the string rim onto the under surface of the lip (Fig. 48), indicating that the lip was formed by tooling the glass at the end of the neck. In other examples, the use of microscopic thin sections demonstrated that at least two possible features were not, in fact, indicative of whether or not glass was added to form the lip. The first of these is a colour/texture difference observable on the lip in Figure 48. The thin section shows the flow lines in the neck extending into the lip, a clear indication glass had not been added. Horizontal grooves just inside the bore (Fig. 7) were also found not to signify the addition of glass, as has been suggested by Haslam (1970: 29-30). These grooves, located near the inner edge of the lip, frequently have the vertical lines and cracks, so characteristic of bores on 18th century "wine" bottles, on both sides of the

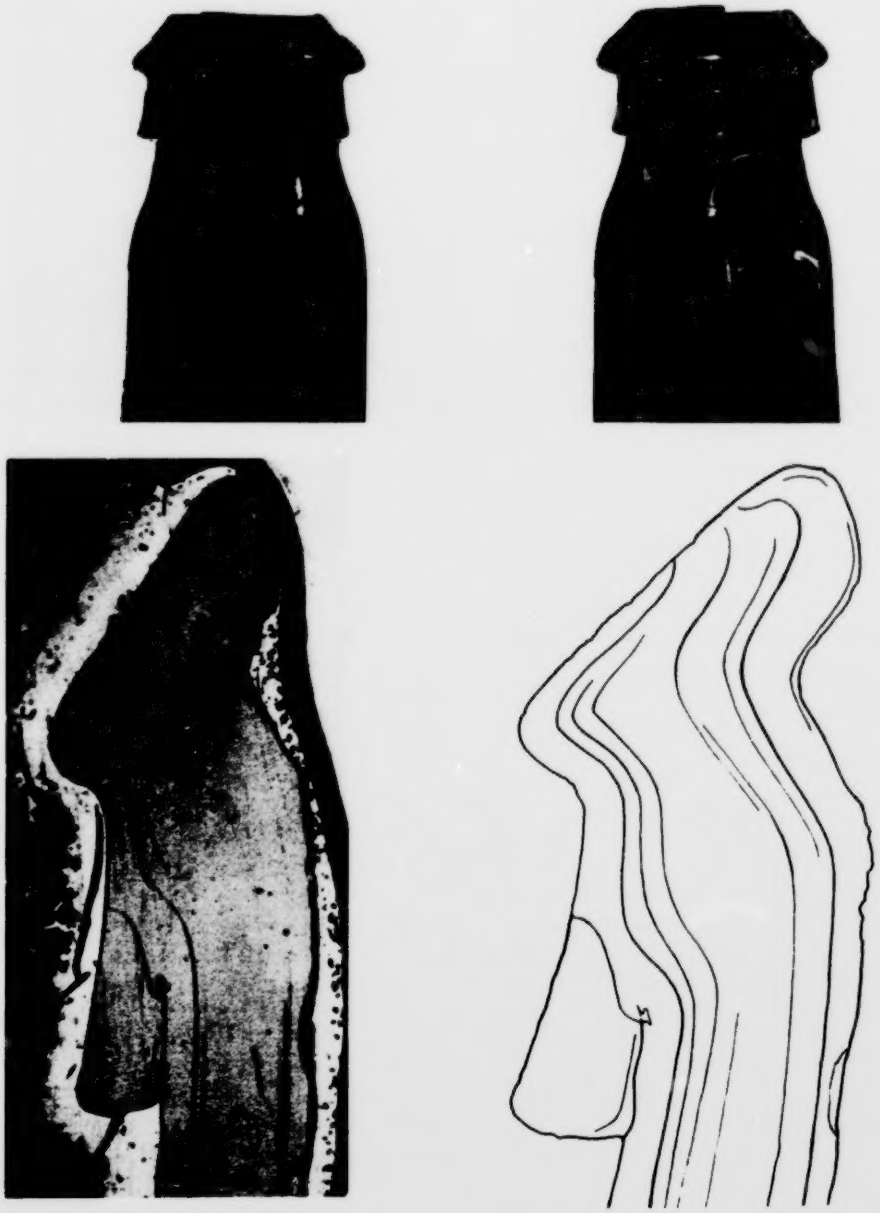


Figure 7. Tooling of crack-off surface has given this lip a down-tooled profile. Groove in the bore is less severe than in Fig. 8. (Thin section and photo by K. Allen; drawing by D. Kappler; photos by G. Lupien; RA-5166B, RA-5165B)

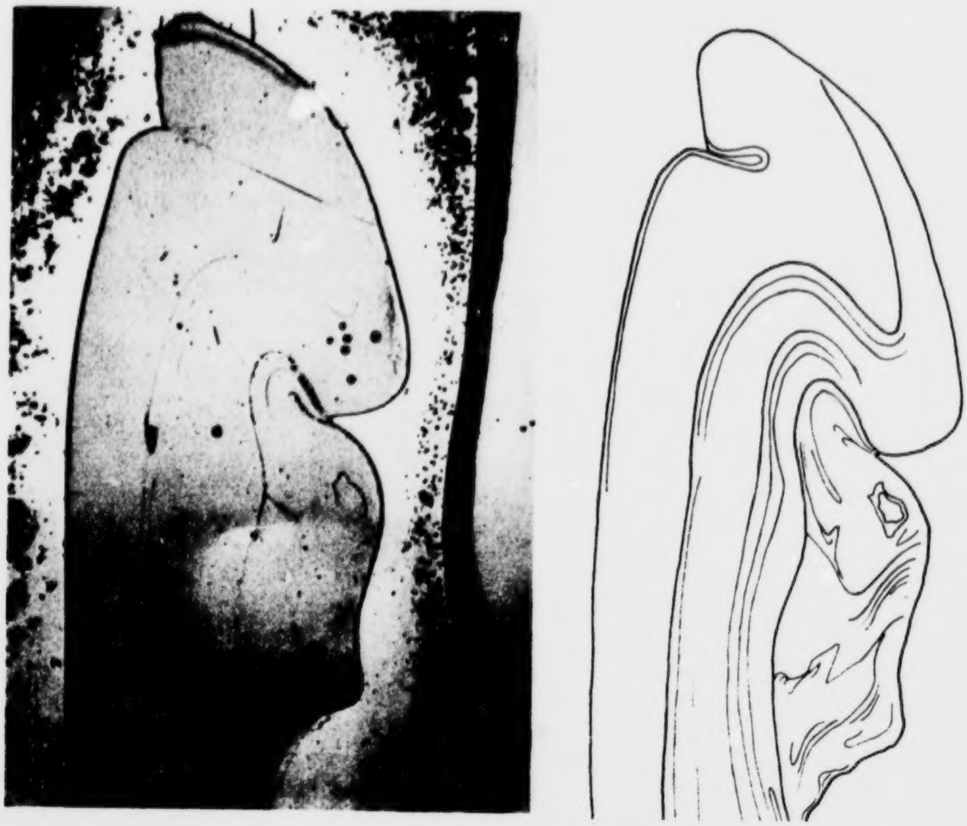


Figure 8. Extensive tooling of crack-off surface has caused lip to extend over the string rim addition and to fold back on itself to form a groove in the bore. (Thin section and photo by K. Allen; drawing by D. Kappler)

groove (Fig. 9). An extreme example with the groove illustrates how much the neck could be tooled to form a down-tooled lip (Fig. 8). In many examples with this groove, the lines of glass addition were clearly visible on the outer surface of the lip. The groove was also found occasionally on Group 1 finishes.

The latest dated bottle with an obvious wide band addition was sealed Wm. Hodge 1800 Lambourn. Generally, the double spiralled addition seems to have predominated. The suggestion by Haslam (1970: 30) that two separate additions were made, one for the lip and one for the string rim appears impractical.

It is not at all improbable that the extra glass for the laid on finish could have been added in two continuous revolutions of the

> bottle on the pontil. In fact, there would be advantages in having a smaller stream of glass that would equalize for thicknesses of the stream, and in the case of thin laid on rings, to finish as a double ring with a groove between it would not require as much work to tool. The "crossover" point, only, would require extra attention. To make *one* circle with the stream [of glass] would require considerable skill in cutting it off so as not to leave either a bulge in the overlapping, or a slight gap (Toulouse 1973: pers. com.).

On many examples the double spiral addition was obvious (Fig. 51).

Forming the lip by adding glass gradually predominated. By the 1820s it was the only way the lip was made. The addition was first made onto the outer surface of the neck and, in many cases, the original crack-off surface was clearly visible (Figs. 10, 41, 44). During the 1820s, however, the addition was also being made with increasing frequency onto the crack-off surface (Fig. 52). An unusually early example with this feature was dated 1802 but may be an accident rather than a deliberate attempt to change the location of the addition. Two other examples were both dated 1817. Very quickly after 1820 the glass added to make the lip began to extend well above the crack-off surface. On many examples dating to the 1820s and later, the inner edge of the crack-off surface is visible as a horizontal line or groove in the bore with the vertical lines or cracks occurring below this groove (Fig. 11). The groove is easily distinguished from the earlier type by its location farther down into the bore and by the fact that the vertical lines and cracks occur below it, not on both sides. The extension of the lip above the crack-off surface appears to be associated with the development of the finish-forming tool (see Finish-Forming Tools following) and is a technique that continued to be used later in the 19th century.

Figure 9. Horizontal groove appears under the lines and cracks that usually mark the inner edge of the crack-off surface. Groove here is clearly not related to any type of addition made to form the lip. (Photo by G. Lupien; RA-12845B)

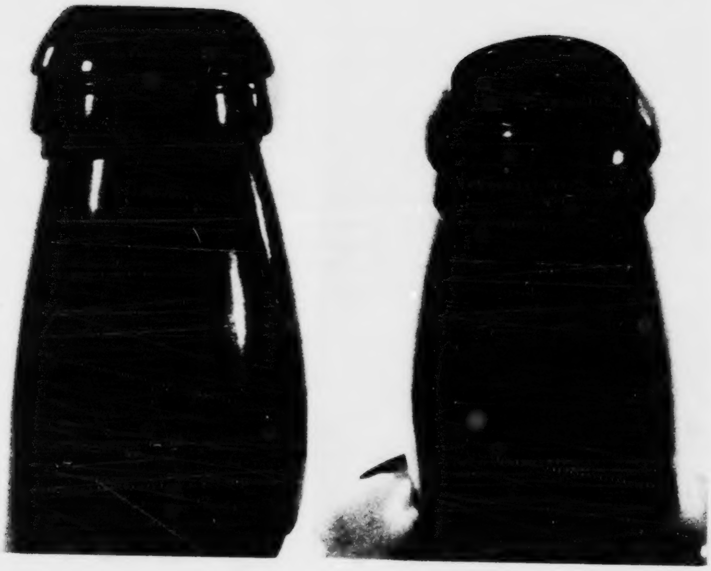


Figure 10. Horizontal line in the bore marks inner edge of crack-off surface, and the vertical lines and cracks are below it. Smooth area above the line is probably the crack-off surface that has been heavily tooled (see also Fig. 44). Glass used to form the finish appears to have been added on outer edge of the neck. (Photos by R. Chan; RA-12822B, RA-12823B)

Figure 11. Fragment shows horizontal line above the vertical grooves and cracks that mark the inner edge of crack-off surface. On examples with the glass addition extending far above the crack-off surface, the line is usually located more than 10 mm below the top of the lip. (Photo by G. Lupien; RA-1664B)

As the lip was thickened either by tooling the glass at the end of the neck or by adding glass, it gradually became taller and a more obvious component of the finish structure. It began to equal and then supersede the string rim as the dominant feature of the finish.

Table 2. Lip formation by decade

	Cracked-off	Cracked-off & fire polished	Tooling crack-off surface	Added glass	May or may not be formed by adding glass	No data	Total
1730-39	2	3					5
1740-49	4	1					5
1750-59	3	9					12
1760-69	4	16	7			1	28
1770-79		6	27	1 [a]		2	36
1780-89	3	3	21	3	3		33
1790-99			19	10	4	1	34
1800-09			6	8	4		18
1810-19			1	12	1		14
1820-29				16			16
1830-39				6			6
1840-49				3			3
1850-59				1			1
Total	16	38	81	60	12	4	211

[a] 1770.

Table 3. Lip thickness by decade

	Same thickness as glass in neck	Slightly thicker than glass in neck	Considerably thicker than glass in neck	No data	Total
1730-39	5				5
1740-49	5				5
1750-59	12				12
1760-69	20	7		1	28
1770-79	5	27	2	2	36
1780-89	6	22	5		33
1790-99		17	15	2	34
1800-09		1 [a]	17		18
1810-19			14		14
1820-29			16		16
1830-39			6		6
1840-49			3		3
1850-59			1		1
Total	53	74	79	5	211

[a] 1801.

Table 4. Lip shapes by decade

	Flat top	Slopes down to string rim	V-shaped	Down-tooled side	Flattened side	Rounded side	Slopes in to bore	Other	No data	Total
1730-39	4							1		5
1740-49	5									5
1750-59	12									12
1760-69	18	4	5						1	28
1770-79	11	19	3	1[a]					2	36
1780-89	8	11	5	5[b]		2[c]	1	1		33
1790-99	2	9	4	17		1		1		34
1800-09			1[d]	16				1		18
1810-19				14						14
1820-29				16						16
1830-39				6						6
1840-49				3						3
1850-59					1					1
Total	60	43	18	78	1	3	1	4	3	211

[a] 1770.
[b] 1784.
[c] 1785.
[d] 1801.

String Rim

On mouth-blown examples of the dark green glass English "wine" bottles the string rim was always formed from added glass. The string rims on the earliest English "wine" bottles were thick and protuberant, generally flat on the top and bottom surface with a rounded edge and sloped downwards. They were located at a considerable distance from the cracked-off lip. By 1700 the string rim was being applied only a few millimetres from the lip. It had become less protuberant and was almost exclusively V-shaped, a shape achieved by tooling both the upper and under surfaces of the glass addition (Fig. 15). The V-shaped string rim remained in production into the 1770s and can be found occasionally on dark green glass liquor bottles whose finishes were formed by finishing tools or by machine. The difference in date can be distinguished easily by examining the lip form and manufacturing techniques used on the finish. In the late 1720s down-tooled string rims (Fig. 14) were introduced and were the predominant style between 1740 and 1770. For a short time, in the 1770s and 1780s, the down-tooled string rim appears to have been out of style as few examples occurred on dated bottles. It reappeared in the 1790s and remained in production until the 20th century. The flattened string rim (Fig. 16) became common in the 1760s. The earliest dated example seen has a seal dated 1738 but generally it was not a significant style until the 1760s. Several examples were recovered from the *Machault*, a ship that sank in 1760 (Sullivan 1979). The flattened string rim has also continued in production into the 20th century. Some examples of string rims of indeterminate shape, generally a thin thread of glass, were observed dating from the mid- to the end of the 18th century. Up-tooling on the under surface of the string rim, a feature common throughout the 18th century, had disappeared by 1800. On up-tooled examples, the results could be V-shaped, could be up-tooled on the under surface and down-tooled on the upper surface, and could have flat sides, a rounded top, or a horizontal top.

Table 5. String rim shape by decade

	V-shaped	Up-tooled bottom down-tooled top	Down-tooled	Flattened side	Up-tooled to flat side	Flat side slopes in to neck	Up-tooled to horizontal top	Up-tooled, top rounded	Thread of glass	Other	No data	Total
1730-39	1	1	2	1								5
1740-49	1		4									5
1750-59	2	1	8						1			12
1760-69	5	4	9	7			1		1		1	28
1770-79	2	2		20	5	4		1			2	36
1780-89		2	6	14	6	4				1		33
1790-99			4	23	4	1	1			1		34
1800-09			6	12								18
1810-19			9	4					1			14
1820-29			10	6								16
1830-39			4	2								6
1840-49			3									3
1850-59			1									1
Total	11	10	66	89	15	9	2	1	3	2	3	211

Bore

For most of the period under consideration very little modification of the bore took place. Vertical lines and cracks found just inside the crack-off surface are the most obvious and common feature and occur even on 17th-century examples. They range in intensity from a few faint lines to actual fissures in the glass (Figs. 9, 27, 41, 43). Their exact cause is unclear. They may have resulted from the action of cracking-off, from thermal incompatibility between the glass surface and tools used in the bore area, or from stresses and strains associated with being close to the blowpipe.

When the finish was formed by adding glass at or onto the crack-off surface, these lines and cracks can still be seen farther down the bore just under a faint horizontal groove that marks the inner edge of the crack-off surface (Figs. 10, 11, 44). By the end of the 19th century this condition was no longer common, probably as the result of the introduction of the separate glory hole for finishes in the 1870s (Toulouse 1969: 534). Many examples from the 1820s and 1830s had been sufficiently reheated that the groove is not visible.

Finish-Forming Tools

Finish-forming tools are used in the hand manufacture of bottles to shape the bore, the lip and string rim. Many different types have been used but generally they have a central mandrel that is inserted into the bore and one or two arms, onto which the exterior finish pattern is cut, which can be squeezed shut around or onto the outer neck surface (Fig. 12).

Finishes made with this type of tool are regularly shaped, including the lower edges of the lip and string rim. If too little glass is added the finish may be irregular (Fig. 53); if too much is added the glass is squeezed out below the finish. Much more complex finishes are possible with this type of tool such as threaded lips and bores, rounded forms, and so on (Figs. 53-54).

Eight "wine" bottles from the 1820s with seals dated 1822 (2), 1823 (2), 1825, 1826, 1827, and 1829 had finishes formed by a finish-forming tool. An example sealed W. HARVEY 1800 COCKTHORPE (Appendix A, No. 149) is so much earlier than any of the other examples that the date on the seal obviously bears no relation to the date of manufacture. Bontemps, writing in 1868, states that he saw finish-forming tools in use during his trip to Britain ca. 1828 (Barker 1977: 60):

> Dans ces mêmes verreries d'Angleterre et d'Ecosse, que je visitai, il y a quarante ans, le verrier, pour former le col et la bague de la bouteille, se servait d'une pince suivant la figure 98 (Bontemps 1868: 512).

His illustrated example resembles the one in Figure 12a. By the 1840s the finish-forming tool appears to have become generally accepted. A British patent taken out in 1844 by Betts and Stocker (Great Britain. Patent Office 1844) included a finish-forming tool designed to make screw threads on the exterior of the finish (Fig. 12b). A description of a one-armed type appeared in the 7th edition of the *Encyclopaedia Britannica*, published in 1842. After adding glass at the mouth of the bottle, the "finisher"

> ...employs a shears to give shape to the neck. One of the blades of this shears has a piece of brass in the centre, tapered like a common cork, which forms the inside mouth; to the other blade is

attached a piece of brass, used to form the ring (*Encyclopaedia Britannica* 1842: Vol. 10, p. 579).

Finish-forming tools became standard equipment in glass factories in the second half of the 19th century and were the subject of innumerable patents in both Britain and the United States even into the first two decades of the 20th century.

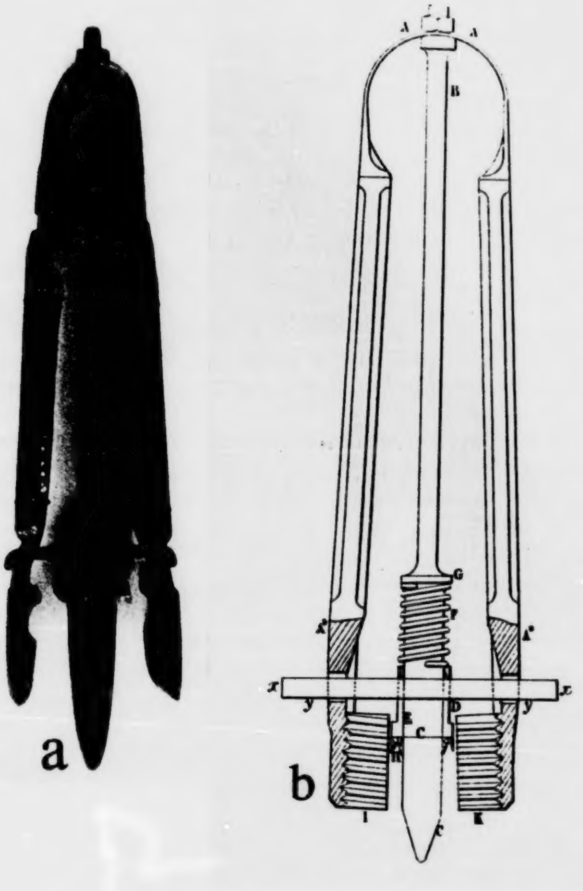


Figure 12. Finish-forming tools came in a great variety of shapes and sizes: (a) is a relatively simple type whereas (b) was designed to make complex threaded and grooved lips. (Great Britain. Patent Office. 1844. Photos by O. Jones, R. Chan; RA-7315B, RD-882M)

Some type of finish-forming tool was being used in the manufacture of dark green glass "wine" bottles in British glass factories during the 1820s. The tool virtually eliminated the abberations so common in the finishes from the earlier periods. From the 1820s onward, there is no longer any question of which shape or size was intended to be made by the glassblower. At the same time the variety of styles available increased dramatically. Also characteristic of the "wine" bottle finishes made during the 1820s and continuing to the present is the complete domination of the lip over the string rim. It was also during the 1820s that the glass added to form the finish extended substantially above the crack-off surface. This feature may be related to the squeezing action of the finishing tool to the glass added to make the finish.

In combination with the three-piece mould and the Ricketts' mould, the finish-forming tool helped to change the appearance of the "wine" bottle, giving it the look that was still adhered to on 20th-century machine-made bottles.

Neck

The neck extends from the bottom of the finish to the beginning of the shoulder. Three shapes were observed: tapered (Fig. 16), roughly cylindrical (Fig. 18), and bulged (Fig. 49). However, the neck diameters, measured under the string rim, at mid-point, and at the base, increased steadily towards the base and did not obviously support the visual impression of the shapes. The tapered neck predominated before 1770 but continued to be made throughout the period under study (Table 6). Occasional examples of the roughly cylindrical neck were observed on bottles dated as early as the late 1730s but they became more common in the 1770s and 1780s. The bulged neck appears to date from the mid-1780s onward. All three types continued in production up to the 1850s.

From ca. 1740 to 1770 the neck height which includes the finish height, generally made up about 40 per cent of the total bottle height. By the late 1760s it was occasionally about 33 per cent of total bottle height and by the early 1800s it was consistently 33 per cent or less of total bottle height. The neck seems to have become wider as it shortened.

After the introduction of the three-piece mould in the early 1820s, a horizontal line and/or a short flattened area sometimes appears at the base of the neck. This mark is left by the top of the mould. The only dated bottle in the sample with a moulded neck was dated 1840 but even on this example the vertical mould lines were only visible on one side of the neck. Nor do archaeological examples dating to the 1820s and 1830s exhibit any kind of mould lines above the base of the neck.

Another neck feature that seems to relate to a manufacturing technique is a distinct flattened area, marked by a horizontal line, found directly under the string rim (Figs. 13, 45). The earliest example seen was dated 1779 but it occurs more frequently after the mid-1780s and is generally associated with Group 3a finishes.

Table 6. Neck shape by decade

	Tapered	Roughly cylindrical	Bulged	Total
1730-39	3	2		5
1740-49	5			5
1750-59	11	1		12
1760-69	22	6		28
1770-79	20	16		36
1780-89	19	12	2	33
1790-99	11	17	6	34
1800-09	5	7	6	18
1810-19	5	8	1	14
1820-29	7	7	2	16
1830-39	4	1	1	6
1840-49	3			3
1850-59		1		1
Total	115	78	18	211

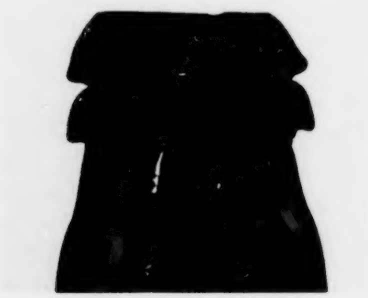


Figure 13. Distinct flattened area found under string rim appears to date from the mid-1780s onward and is generally associated with the Group 3a finishes; the cause is unknown. (Photo by G. Lupien; RA-1759B)

CATALOGUE OF FINISH STYLES

Group 1

The lips of this group are the same thickness as the glass in the neck and have been formed by cracking-off or cracking-off and then fire-polishing. Two basic shapes occur – flat-topped and V-shaped; some examples have a sloped top that is not really V-shaped or have no particular shape. The string rim dominates the finish.

The flat-topped version was the first style found on English "wine" bottles and continued in production after the introduction of the cylindrical body. It was the predominant style in the 1730s, 1740s and 1750s but was gradually replaced by other styles in the 1760s. Occasional examples of the flat-topped lip occurred in the 1770s and even as late as 1785. The earlier string rims were generally V-shaped, down-tooled (Figs. 14, 15) or a shape that could have been either after an additional bit of tooling (Fig. 17). The flattened string rim started in general use in the 1760s (Fig. 16) although one bottle (Appendix A, No. 3) dated 1738 had a string rim of this shape. String rims with an up-tooled to flattened side date to the 1770s.

In this sample the V-shaped lip began to appear in the 1760s but it also occurred as early as the 1730s on dated non-cylindrical bottles. The last dated lip of this type was on a bottle dated 1783. The V shape appears to have been achieved either by widening the top of the bore (Fig. 19) or by constricting the neck at the string rim. String rims associated with this form were down-tooled, flattened, up-tooled to a flat side, and up-tooled bottom with down-tooled top.

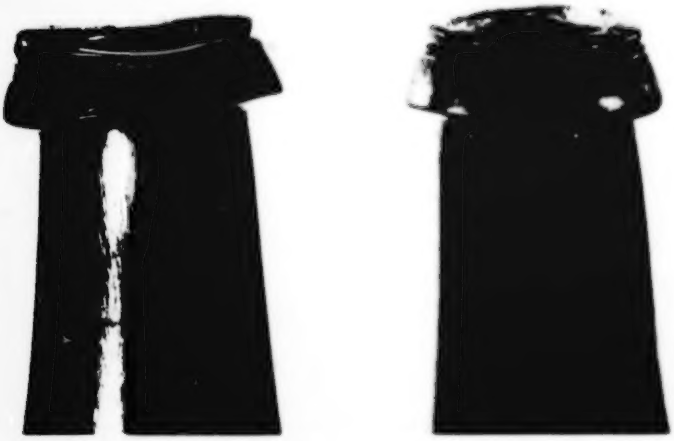


Figure 14.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: flat top
String rim shape: down-tooled
Dated examples: 1738-39 (2), 1740-49 (4), 1750-59 (8), 1760-65 (4)

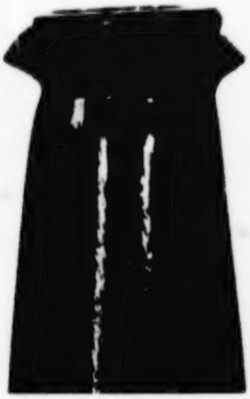


Figure 15.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: flat top
String rim shape: V-shaped
Dated examples: 1737 (1), 1740-49 (1), 1750-59 (2), 1760-69 (4), 1770-74 (1)

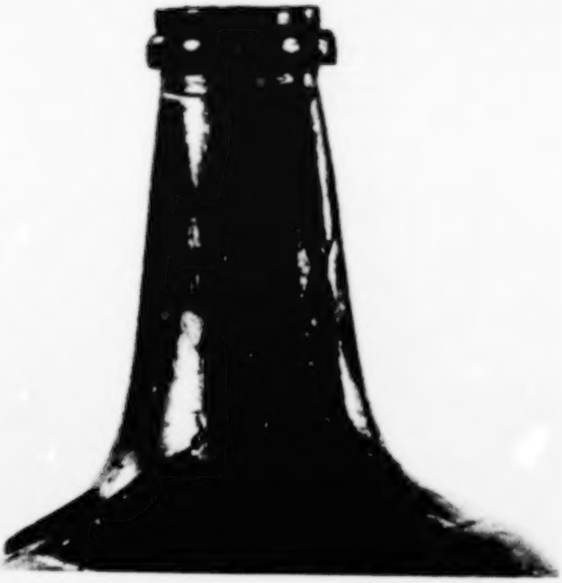


Figure 16.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: flat top
String rim shape: flattened
Dated examples: 1765-69 (3), 1770-79 (1), 1780-85 (2)

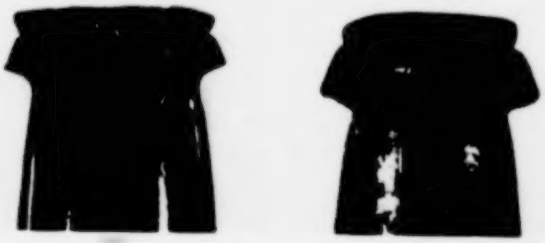


Figure 17.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: flat top
String rim shape: up-tooled bottom, down-tooled top (slightly more slope in either direction would give either a V-shaped or down-tooled string rim)
Dated examples: 1737 (1), 1750-59 (1), 1760-69 (2), 1780-81 (1)

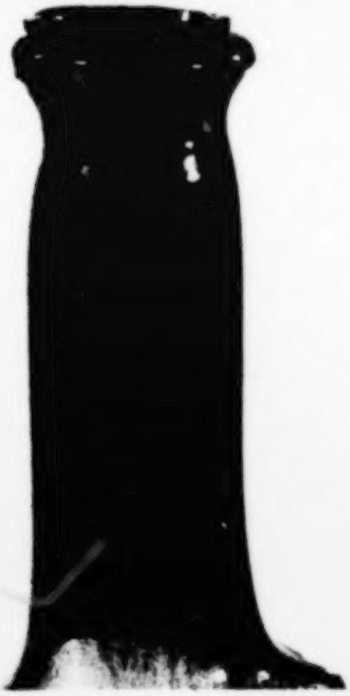


Figure 18.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: flat top
String rim shape: up-tooled to flattened side
Dated examples: 1770-71 (4)

Not illustrated:
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: flat top
String rim shape: indeterminate
Dated examples: 1756, 1765

Not illustrated:
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: flat top
String rim shape: up-tooled to a horizontal top
Dated example: 1762

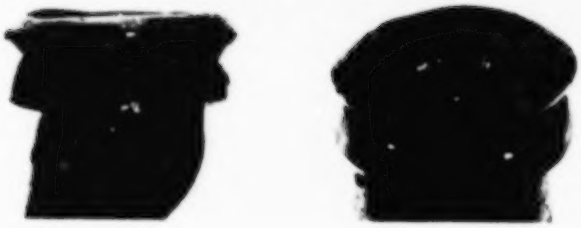


Figure 19.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: V-shaped
String rim shape: down-tooled
Dated examples: 1763, 1765, 1783

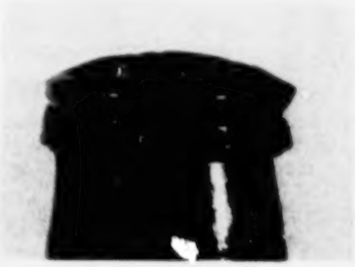


Figure 20.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: V-shaped
String rim shape: up-tooled to flattened side
Dated example: 1780

Not illustrated:
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: V-shaped
String rim shape: flattened
Dated example: 1764

Not illustrated:
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: V-shaped
String rim shape: up-tooled bottom, down-tooled top
No dated examples

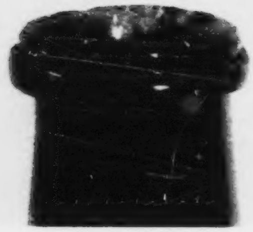


Figure 21.
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: slopes down
String rim shape: flattened
Dated examples: 1765, 1786

Not illustrated:
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: top slopes down
String rim shape: up-tooled to flattened side
No dated examples

Not illustrated:
Lip thickness: same as glass in neck
Lip formation: cracked-off/cracked-off & fire-polished
Lip shape: overly fire-polished, no definite shape
String rim shape: flattened
Dated example: 1738

Group 2

The lips in this group are slightly thicker than the original neck surface, an effect achieved by tooling and/or heating the cracked-off surface and possibly by expanding the top of the bore. This group of lips was extremely difficult to categorize, particularly those produced during the change over periods. Earlier versions can be confused with Group 1 lips and later versions with Group 3a lips. They also tend to be uneven, one side of the lip varying in shape from the other.

The predominant lip shapes are down-sloped, flat-topped, and V-shaped and the dominant string rim styles are flattened, up-tooled to flattened side, and flat side sloping in towards the neck. Generally the string rim is placed very close to the lip. Some down-sloped lips would undoubtedly be V-shaped if the string rim had been placed lower down.

The general date range for this group of finishes is 1761 to 1801.

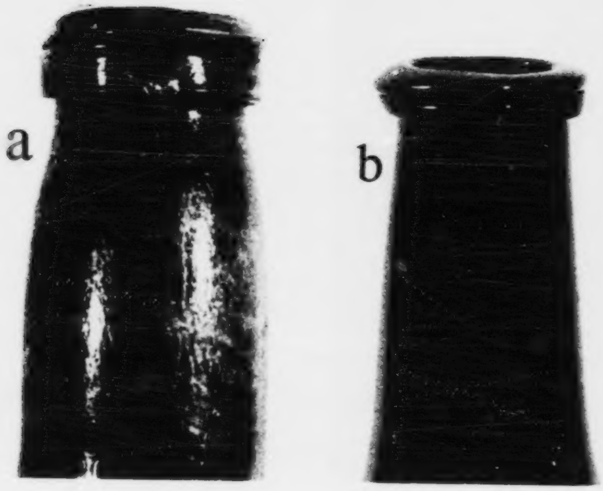


Figure 22.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: slopes down to string rim
String rim shape: flattened side
Dated examples: 1765-69 (2), 1770-79 (16), 1780-89 (4), 1790-96 (7)
Many of the down-sloped lips (a) would be V-shaped if string rim were placed farther down the neck.

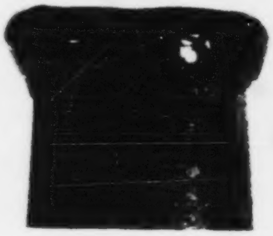


Figure 23.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: slopes down to string rim
String rim shape: flat side slopes in to neck
Dated examples: 1779 (2), 1784 (2), 1786

Figure 24.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: slopes down to string rim
String rim shape: up-tooled to flat side
Dated examples: 1781, 1784, 1796

Figure 25.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: slopes down to string rim
String rim shape: up-tooled bottom, down-tooled top
Dated example: 1766

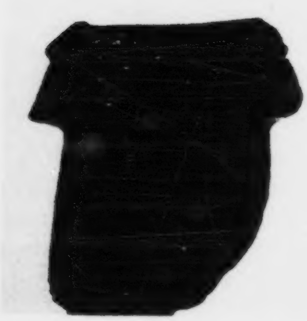


Figure 26.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: slopes down to string rim
String rim shape: down-tooled
Dated example: 1794

Not illustrated
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: lip slopes down to string rim
String rim shape: V-shaped
Dated example: 1774

Figure 27.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: flat top
String rim shape: up-tooled to flat side
Dated examples: 1770, 1775, 1780, 1785, 1790

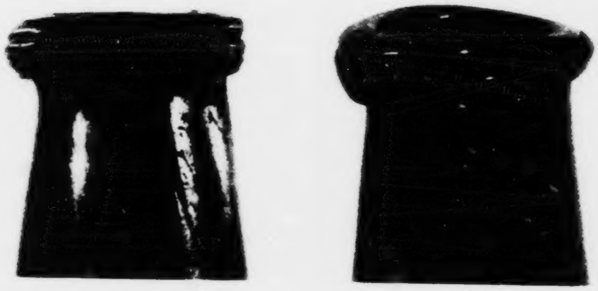


Figure 28.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: flat top
String rim shape: flat, slopes in to neck
Dated examples: 1771, 1779, 1789

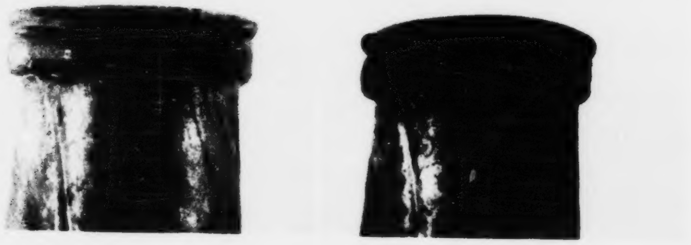


Figure 29.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: flat top
String rim shape: flattened side
Dated examples: 1783 (2), 1793

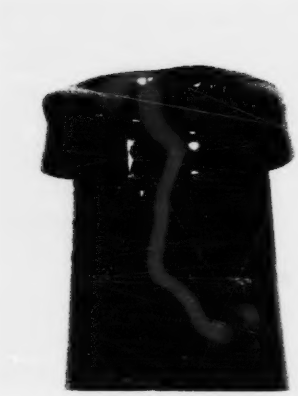


Figure 30.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: flat top
String rim shape: down-tooled
Dated examples: 1767 (2)

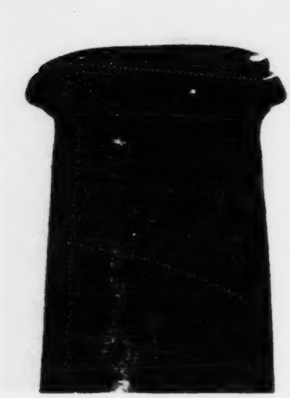


Figure 31.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: flat top
String rim shape: up-tooled bottom, down-tooled top
Dated examples: 1775, 1779

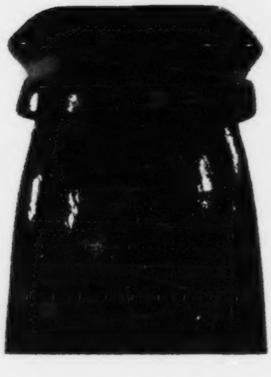
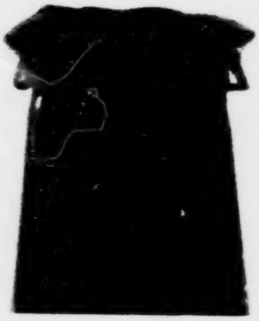


Figure 32.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: V-shaped
String rim shape: flattened
Dated examples: 1772, 1793, 1801

Figure 33.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: V-shaped
String rim shape: down-tooled
Dated examples: 1784, 1785, 1788



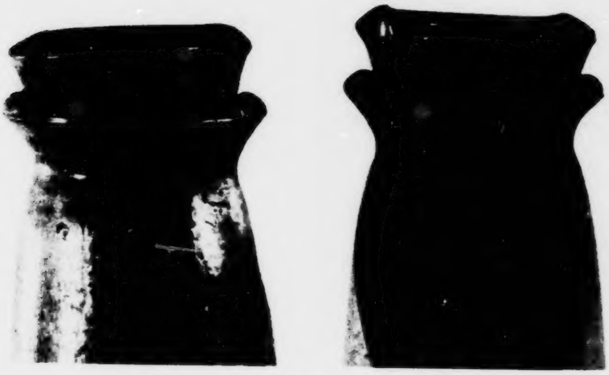
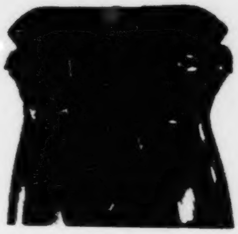


Figure 34.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: V-shaped
String rim shape: up-tooled to rounded top
Dated examples: 1770, 1796

Figure 35.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: V-shaped
String rim shape: up-tooled to flat
Dated examples: 1795, 1796



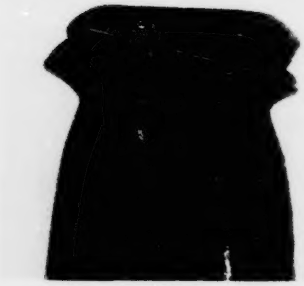


Figure 36.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: V-shaped
String rim shape: V-shaped
Dated example: 1761

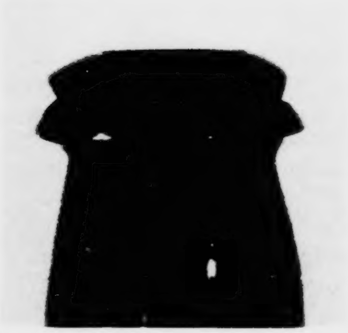


Figure 37.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: V-shaped
String rim shape: up-tooled bottom and down-tooled top
Dated example: 1761

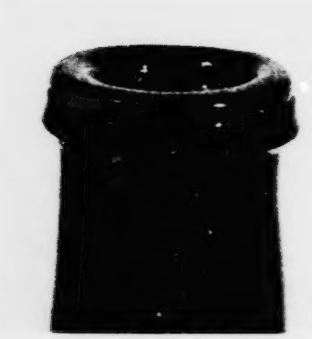


Figure 38.
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: slopes in to bore
String rim shape: flattened side
Dated example: 1786

Not illustrated:
Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: slopes in to bore
String rim shape: up-tooled to flattened side
Dated example: 1788

Figure 39.

Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: rounded top and side
String rim shape: down-tooled
Dated example: 1785

Lip appears to have been extensively heated, giving it a rounded appearance. It was probably originally intended to be V-shaped.

Not illustrated:

Lip thickness: slightly thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: rounded top and side
String rim shape: flattened side
Dated examples: 1785, 1791

Group 3a

The lips in this group are considerably thicker than the glass in the original neck surface, an effect achieved either by tooling the crack-off surface or by adding glass to the outer edge of the neck. In many examples there is no evidence of how the lip was formed but as both techniques were introduced about the same time there is no dating significance between them. However, beginning in the 1820s virtually all lips were formed by adding glass (see Group 3b). The wide band of addition (Fig. 40) may be slightly earlier.

Introduced about 1785, the downslope of the lips in this group is much stronger than in the previous groups and considerably exceeds the underside of the lip. One example (Appendix A, No. 51) dated 1770 appears to be out of sequence and was probably manufactured considerably later than the seal date suggests. Lip shapes for this group are down-tooled or flattened. The earlier lips of this type tend to be about the same height as the string rims but in the 1820s they become distinctly taller.

The string rim forms are predominantly flattened or down-tooled. In the late 1780s and early 1790s an up-tooled/down-tooled example and one with a flat side sloping in towards the neck also occurred. Some string rims were of an indeterminant shape.

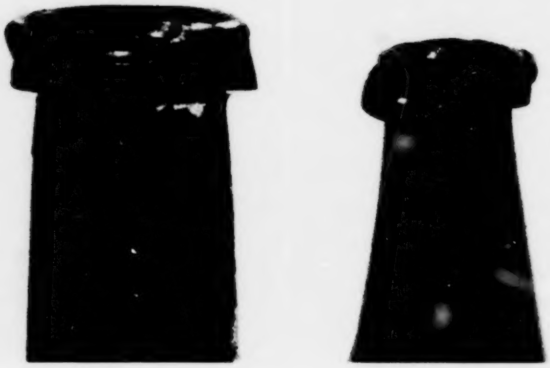


Figure 40.
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, wide band on outer edge of neck
Lip shape: sloped down to string rim
String rim shape: down-tooled or flattened
Dated examples: 1778, 1780

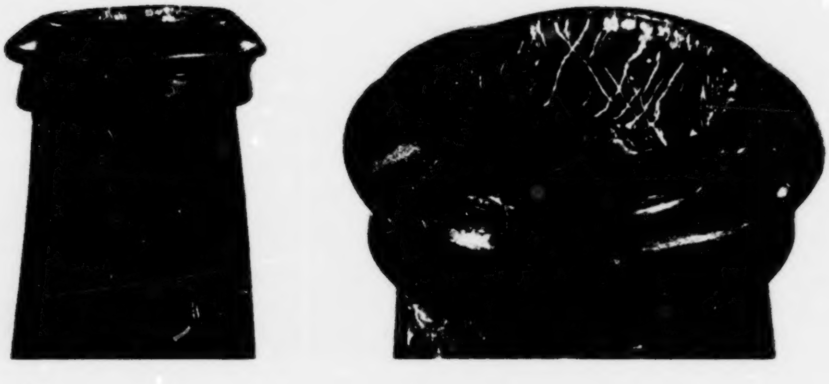


Figure 41.
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass on outer edge of neck
Lip shape: down-tooled
String rim shape: flattened
Dated examples: 1793-99 (6), 1800-09 (5), 1810-19 (3), 1820-22 (2)
Crack-off surface is visible and glass to form lip was added to outer edge of the neck.

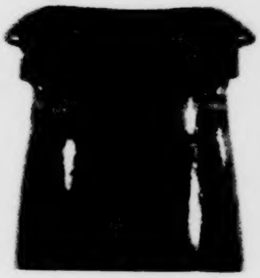


Figure 42.
Lip thickness: considerably thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: down-tooled
String rim shape: flattened side
Dated examples: 1785-89 (2), 1790-99 (3), 1800-09 (2), 1810-11 (1)

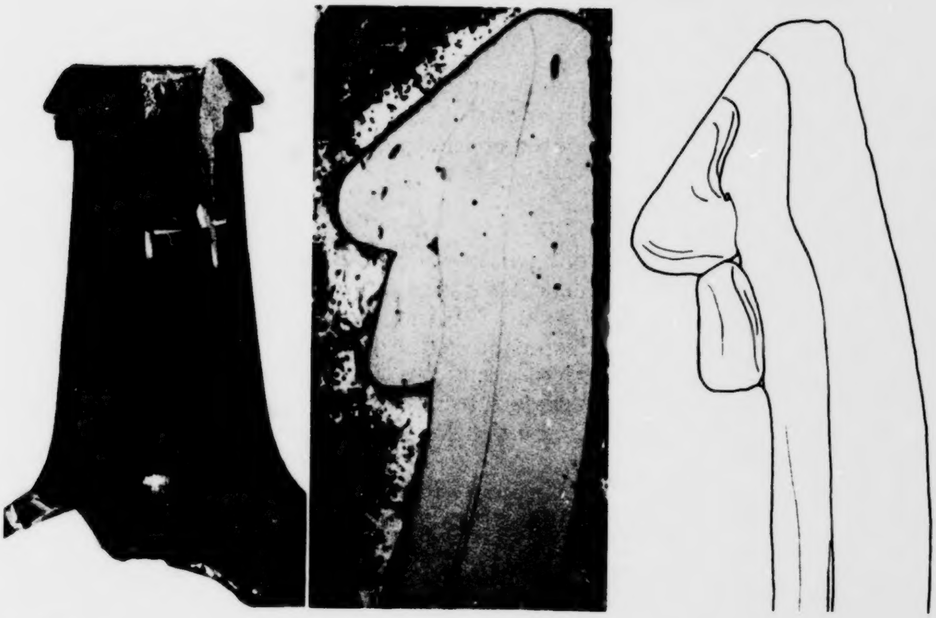


Figure 43.
Lip thickness: considerably thicker than glass in neck
Lip formation: may or may not be formed by adding glass
Lip shape: down-tooled
String rim shape: flattened
Dated examples: 1793-99 (4), 1800-06 (3)

It was impossible to determine visually how lip was formed. Thin section, however, shows that a separate addition was made to outer edge of the neck. Vertical lines and cracks in the bore stop at crack-off surface and mark the inner edge of the lip. (Thin section and photo by K. Allen; drawing by D. Kappler; photo by G. Lupien.)

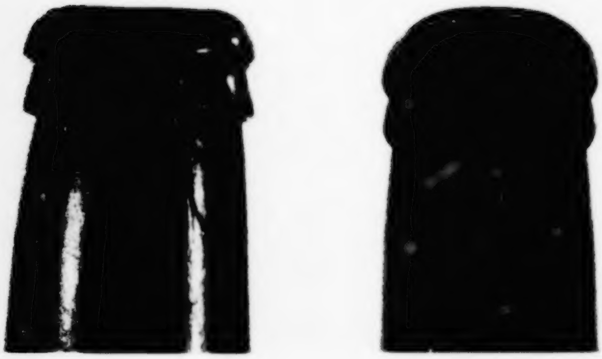


Figure 44.
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass on outer edge of neck
Lip shape: down-tooled
String rim shape: down-tooled
Dated example: 1794-99 (2), 1800-09 (1), 1810-19 (6), 1820 (2)

Crack-off surface appears to have been pushed up slightly, possibly by reheating. Inner edge of crack-off surface is marked by vertical lines and cracks in the bore that end about 2-3 mm below the top of lip. This feature was observed on bottles dated in the late teens and early twenties. In these examples the addition to form the lip still appears to have been made on the outer edge of the neck although on some examples it may have been at least partially added to the crack-off surface.

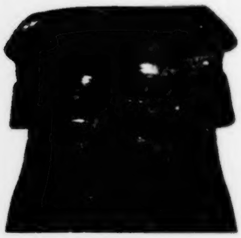


Figure 45.
Lip thickness: considerably thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: down-tooled
String rim shape: down-tooled
Dated examples: 1788, 1809 (3)

Not illustrated:
Lip thickness: considerably thicker than glass in neck
Lip formation: may or may not be formed by adding glass
Lip shape: down-tooled
String rim shape: down-tooled
Dated examples: 1787, 1808, 1815 (2)

Figure 46.

Lip thickness: considerably thicker than glass in neck

Lip formation: tooling crack-off surface

Lip shape: down-tooled

String rim shape: flat side slopes in to neck

Dated example: 1793

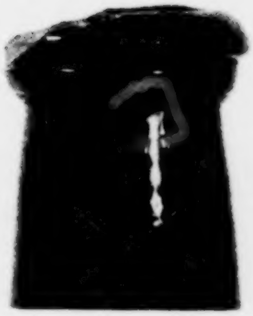


Figure 47.

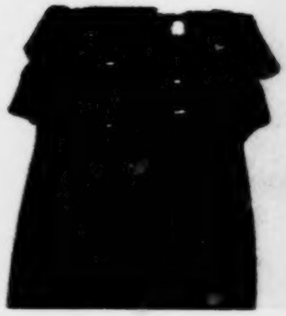
Lip thickness: considerably thicker than glass in neck

Lip formation: may or may not be formed by adding glass

Lip shape: down-tooled

String rim shape: up-tooled bottom, down-tooled top

Dated example: 1784



Not illustrated:

Lip thickness: considerably thicker than glass in neck

Lip formation: may or may not be formed by adding glass

Lip shape: down-tooled

String rim shape: thread of glass of indeterminant shape

No dated examples

Not illustrated:

Lip thickness: considerably thicker than glass in neck

Lip formation: added glass on outer edge of neck

Lip shape: down-tooled

String rim shape: thread of glass of indeterminant shape

Dated examples: 1794, 1810

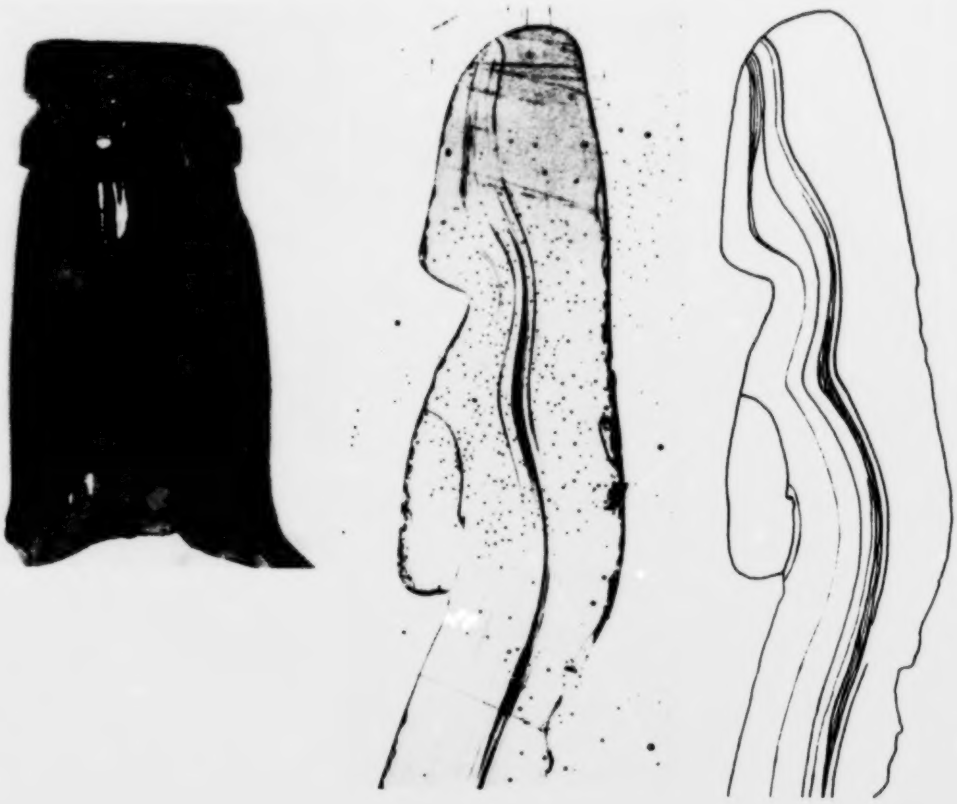


Figure 48.
Lip thickness: considerably thicker than glass in neck
Lip formation: tooling crack-off surface
Lip shape: flattened
String rim shape: flattened
No dated examples
Band of discolouration, apparently a form of patination, is clearly not an indication of added glass, as thin section shows lip was formed by tooling. Groove on the neck continues under string rim and onto lower surface of the lip. (Photos by G. Lupien, K. Allen; drawing by D. Kappler; thin section by K. Allen)

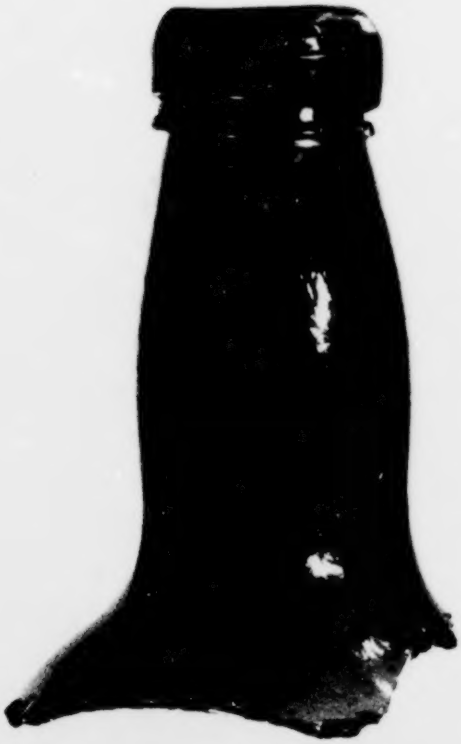


Figure 49.
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, on outer edge of neck
Lip shape: flattened
String rim shape: thread of glass of indeterminant shape
No dated examples

Not illustrated:
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass on outer edge of neck
Lip shape: flattened
String rim shape: flattened
No dated examples

Not illustrated:
Lip thickness: considerably thicker than glass in neck
Lip formation: may or may not be formed by adding glass
Lip shape: flattened side
String rim shape: flattened side
No dated examples

Group 3b

This group generally appears to have lips formed from added glass; in some examples it is clearly added to the outer edge and in others the location cannot be determined. The finish is sufficiently even and well-formed that it is possible some type of finish-forming tool was used, although there is enough uneveness to raise a doubt. The finishes tend to have down-tooled lips and down-tooled or flattened string rims. They generally date from ca. 1820 and later. One example (Appendix A, No. 149) dated 1800 is out of sequence and was probably made much later than the date on the seal suggests.

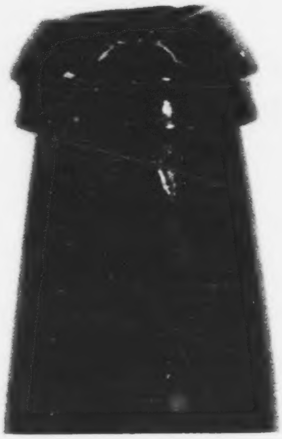


Figure 50.
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, location not always clear
Lip shape: down-tooled
String rim shape: down-tooled
Dated examples: 1819, 1827, 1834, 1836, 1840

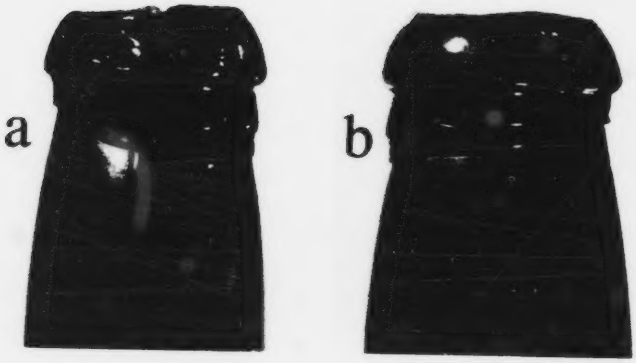


Figure 51.
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, location not always clear
Lip shape: down-tooled
String rim shape: flattened side
Dated examples: 1800, 1822, 1823, 1826, 1827, 1837
The point where the glassmaker began adding glass is visible in (a), as is the original neck surface beside it. Glass was added in a double spiral which ends on the other side of the neck as a thin thread of glass (b). Irregularities stem from poorly applied glass, otherwise, bore diameter, the under-edges of the lip and string rim, and lip and string rim heights are even and well-formed suggesting some type of finish-forming tool was used.

Group 3c

Well-formed, even finishes, clearly shaped by finish-forming tools appeared on bottles dated as early as 1822. The variety of shapes and finish styles available to the glassmaker increased dramatically. The dated sample examined remained relatively conservative, concentrating on down-tooled or flattened lips and string rims. Finishes from archaeological sites dating from the 1820s to 1850s show a greater variety of forms (see Figs. 53, 54).

All of these lips were formed by adding glass although the location is not always clear and on many well-made examples there is no visible evidence for the addition. In the bore the horizontal line above vertical lines and cracks (Fig. 11) indicates that on many examples the addition extended well above the crack-off surface. In others (Figs. 10, 44) where the line is within 2-3 mm of the top of the lip, the addition was probably made on the outer edge of the neck and the smooth area above the horizontal lines is probably the crack-off surface.

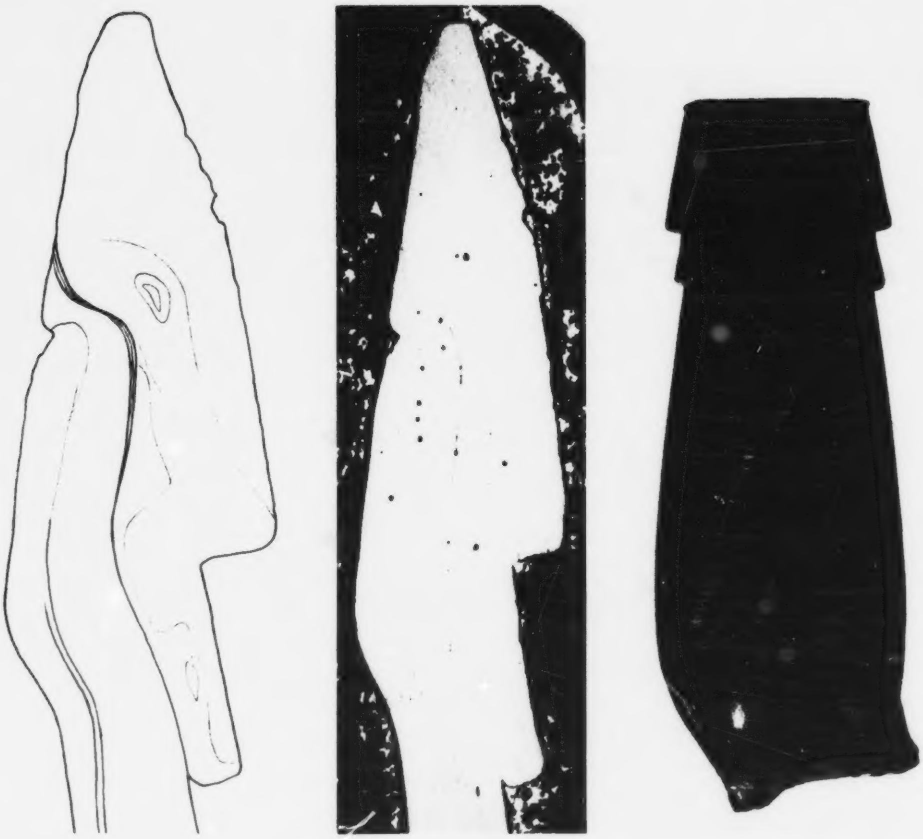


Figure 52.
Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, location varies
Lip shape: down-tooled
String rim shape: down-tooled
Dated examples: 1822-29 (7), 1830-39 (2), 1840-49 (2)
Thin section shows location of added glass used to form the lip. Thin section and photo by K. Allen; drawing by D. Kappler; photo by G. Lupien.

Figure 53.

Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, location varies
Lip shape: rounded
String rim shape: rounded
No dated examples

This style could only be formed using a finish-forming tool. Several of these were found on bottles with basal sag and which were made in three-piece moulds. The combination of features indicates they were probably made in 1820s or 1830s.

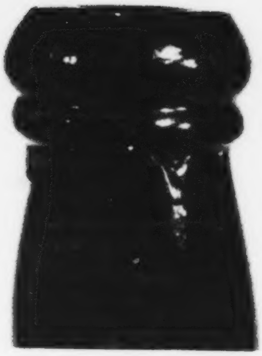
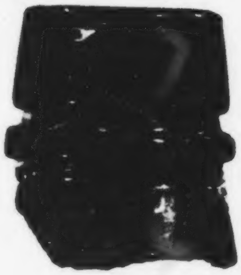


Figure 54.

Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, location varies
Lip shape: down-tooled
String rim shape: flattened
No dated examples

This style, with deliberate groove between lip and string rim, has been found in contexts dating to ca. 1835-55. It is one example of the variety of styles made possible by finish-forming tools.



Not illustrated:

Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, location varies
Lip shape: down-tooled
String rim shape: flattened
Dated examples: 1823, 1828, 1836

Not illustrated:

Lip thickness: considerably thicker than glass in neck
Lip formation: added glass, location varies
Lip shape: flattened
String rim shape: down-tooled
Dated example: 1858

BODIES

Style

Frequently changing body shapes was one of the most characteristic alterations in the early English "wine" bottles. The cylindrical form appeared in the late 1730s following the onion-shaped body and co-existing for some time with the mallet-shaped form — one with straight sides sloping out towards the base. Many authors have linked the development of the cylindrical body to the increasing use of bottles for maturing wine, primarily port (Simon 1926: 235; Wills 1968: No. 10, p. 3). As pointed out before, however, binning was known and practised in the 17th century; the bulbous-shaped bottles were simply stored upside-down in specially designed racks. The cylindrical bottles, particularly the taller narrower versions, can be more efficiently stacked on top of each other in a confined space, but the original impetus for the development of the cylindrical body was probably related to the increasing use of the dip mould in the 1730s (see Manufacturing Techniques). The cylindrical body can be formed in a dip mould whereas the earlier styles could not.

At the beginning of this study I assumed that the cylindrical-bodied "wine" bottle was basically one style. The variations evident in the many archaeological examples that I examined and in the published illustrations could be explained in two ways: the bottles were becoming taller and narrower through time, and manufacturing techniques from the period were such that most consumers did not expect bottles of precise dimensions. Nevertheless, I believed that the bottlemakers, operating within a wide tolerance range, were attempting to make bottles of one "look" at any one time period. After I measured the dated group, however, I realized that there was more than one "ideal" style. These style variations could be associated with different measuring systems (and intended contents) and each style changed through time.

Three systems of measure seem to have been in force in the bottles measured (see Capacity): the English ale/beer gallon (quart 1155 mL), the Queen Anne wine gallon (quart 946 mL), and the imperial gallon (quart 1136 mL) introduced in 1825. I have not considered the Irish and Scottish systems partly because the majority of the sealed bottles I examined seem to be English in origin, partly because general trade with North America in the 1740-1850 period was through London, Bristol, and Liverpool, and partly because the Scottish chopin and Irish quarts are within the "quart" ranges found in the measured bottles and would be almost impossible to isolate. Also, the English factories produced and exported considerably more bottles than did the Scottish or Irish factories. For example, in 1826 English bottle factories paid excise duty on 332 591 Cwts, Scottish factories on 86 384 Cwts, and Irish factories on 3568 Cwts. The amount of the drawback given on bottles during the 1820s demonstrates the overwhelmingly dominant position held by the English factories in the export market (Great Britain...1835: 79).

Using a combination of capacity, date of manufacture, base diameter, body height, and the difference between the two measurements (Fig. 60 and Appendix B, Tables 7-23), I have identified four distinct styles in the "quart" size range: beer-style, wine-style, undersize beer-style, and imperial wine-style.

There is some historical evidence for the existence of these styles but it is late. The trade card in Figure 55, dating after 1821, illustrates two styles, a tall slender one for wine and cider and a short wide one for beer and porter. McKearin and Wilson (1978: 229-32) also found considerable American evidence for a specialized "porter" bottle, of which those manufactured in England were highly regarded. These tended to have a wide short body, as shown by illustrations in American newspapers between 1815 and 1830. If a distinction was made between wine- and beer-styles by the 1820s, how far back did this distinction go? There is some evidence in the bottles from this study that three different styles were being made in the 1737-50 period but the number of bottles is too small to be sure. By the 1750s and 1760s, however, there does seem to have been a deliberate attempt by the manufacturers to make bottles in different styles. Because I lacked sufficient data I could not examine either the onion- or mallet-shaped forms.

Beer-Style Quarts (Fig. 60 and Appendix B, Tables 7, 10-12, 18)

All these quarts had capacities ranging from ca. 950 mL to ca. 1250 mL suggesting that they were made in the ale/beer measure (see Capacity). Judging by the distribution of variability in the capacities of the bottles, the capacity range seems to have remained relatively constant throughout the period. The earliest examples of this style (Table 7), dating from 1737 to 1773, had base diameters considerably larger than the body heights. The second group (Tables 10-12, Fig. 57b) had three variants. Introduced in the 1750s, it generally had a "square" body, with the base diameters and body heights close to the same value. Beginning in the late 1760s the body height was sometimes greater than the base diameter. The "square" look, in all three variations, continued to be produced until the early 19th century. In the 1790s a third modification was made (Table 18). The bodies were considerably taller than the base diameters but the body style continued to be shorter and wider than its wine-style counterpart (compare Table 18 with Tables 20-22). Each of the modifications made in the beer-

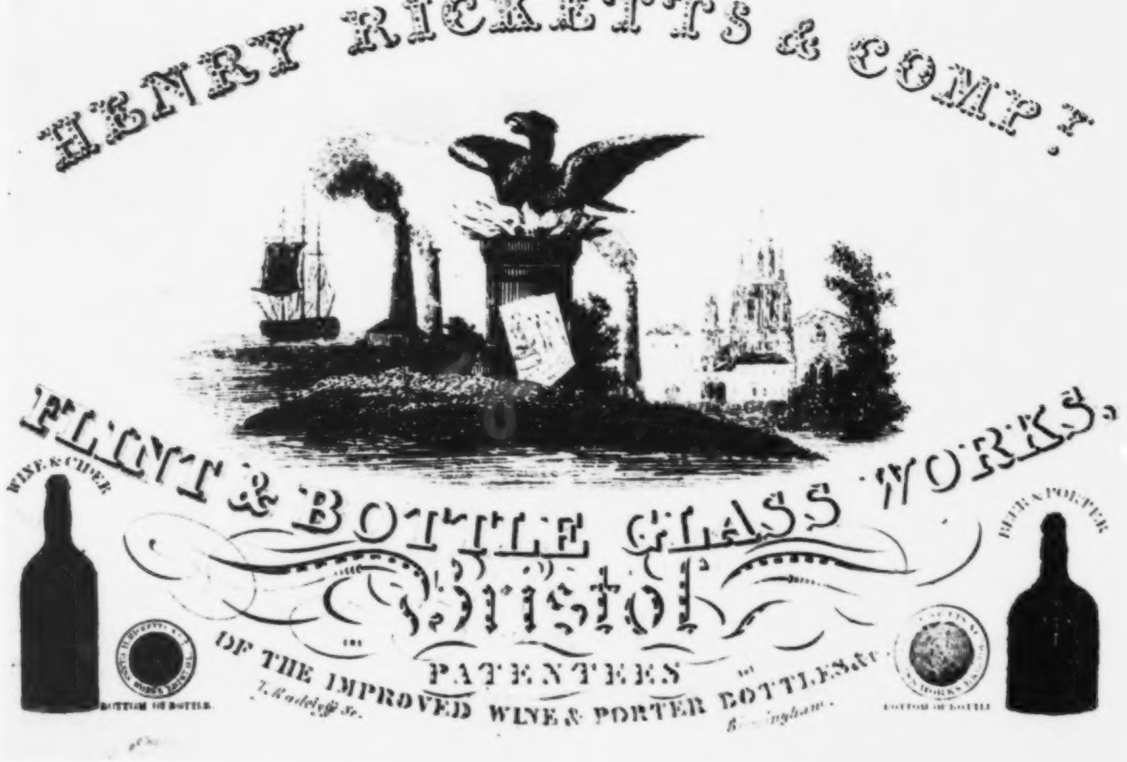

HENRY RICKETTS & COMP.Y
FLINT & BOTTLE GLASS WORKS,
Bristol
WINE & CIDER
BEER & PORTER
BOTTOM OF BOTTLE
PATENTEES
OF THE IMPROVED WINE & PORTER BOTTLES &c

Figure 55. Trade card of Henry Ricketts Company, Bristol, dated between 1821 and 1852 shows two bottle styles – tall slender one for wine and cider, and short wide one for beer and porter. (Courtesy City of Bristol Museum and Art Gallery)

style quart involved a narrowing of the body/base diameters and a lengthening of the body. The changeover periods, when both the older shape and the new shape were in production, were the 1750s-60s and ca. 1790-1810.

Almost all the large beer-style quarts used in this study occurred in the dated group. They appear to be relatively rare on sites in North America, however. The measurable dark green glass 18th-century English bottles excavated at Fort Michilimackinac held between 23 and 26 ounces (Brown 1971: 101). In a group of bottles lost at the battle of Yorktown in 1781, 97 had capacities under 950 mL and six had capacities over 950 mL

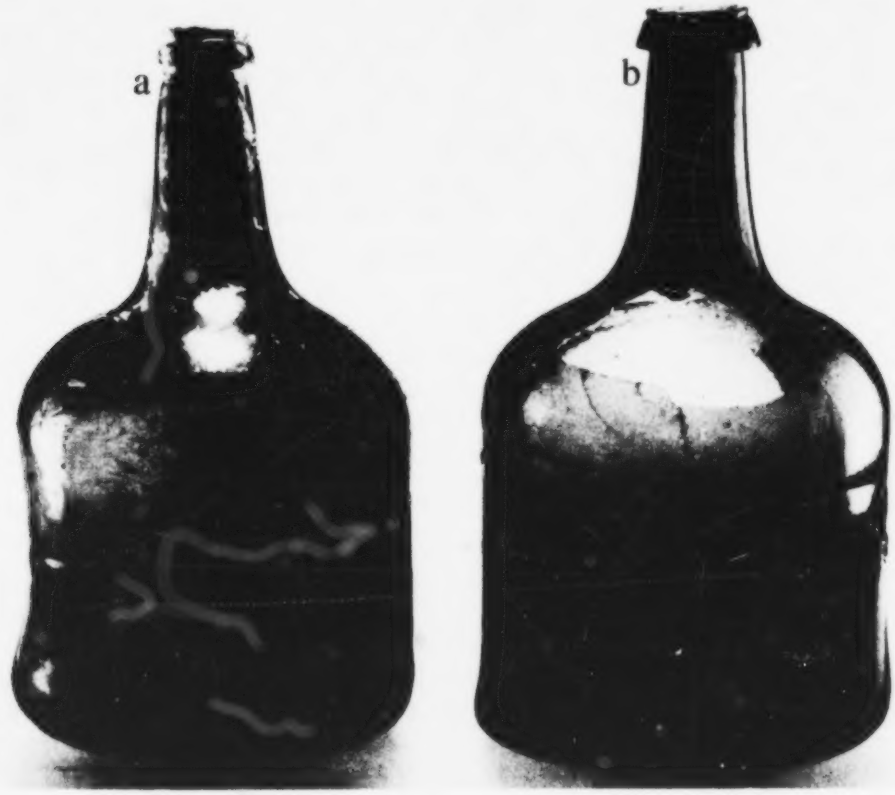


Figure 56. Pair of wine-style quarts from the *Machault*, which sank in 1760. a) Bottle height: 206 mm; body height: 90 mm; base diameter: 119 mm; estimated capacity: 848 mL. b) Bottle height: 212 mm; body height: 95 mm; base diameter: 118 mm; estimated capacity: 894 mL. (Photo by R. Chan)

(Sands 1974: Figs. 3, 4, 6-8). Base fragments of dark green glass bottles from the Fort at Coteau-du-Lac dating between 1780 and 1820, seldom exceeded 100 mm in diameter (Jones 1975), suggesting that the larger beer quarts were absent from the site. One rarely, of course, finds bottles from excavations that are complete enough to measure for capacity, but the base diameters and date of manufacture can be used as a general guide for identifying the large beer quarts.

Wine-Style Quarts (Fig. 60 and Appendix B, Tables 9, 16-17, 20-22)

These quarts had capacity ranges from ca. 675 mL to ca. 950 mL,

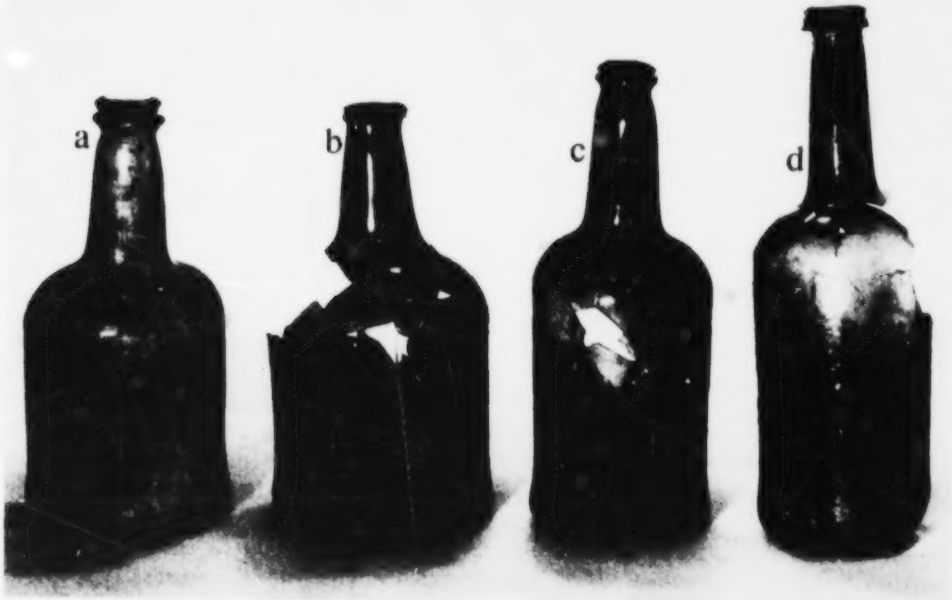


Figure 57. Group of bottles dating between ca. 1760 and 1800 shows difference in style between contemporary beer- and wine-style bottles. a) Undersized beer style. Bottle height: 232 mm; body height: 110 mm; base diameter: 106.5 mm; estimated capacity: 788 mL. b) Beer-style. Bottle height: 227 mm; body height: 112 mm; base diameter: 118 mm; estimated capacity: 1109 mL. c) Wine-style. Bottle height: 253 mm; body height: 135 mm; base diameter: 96 mm; estimated capacity: 763 mL. d) Wine-styles. Bottle height: 282 mm; body height: 152 mm; base diameter: 93 mm; estimated capacity: 860 mL. (Photo by R. Chan; RA-14163B)

suggesting that they were made in the wine measure. Judging by the distribution of variability in the capacities of the bottles, the capacity ranges for this style seem to have decreased gradually in the period in question. The earliest examples (Table 9, Fig. 56), dating from the 1740s to the early 1770s, have wider base diameters than body heights but tend to have a slightly taller body than the beer-style bottles of the same period. The second group (Tables 16-17, Fig. 57c-d) emerged abruptly in the early 1760s and is the one normally recognized as the classic "wine" bottle. The body is tall and narrow compared with the beer-style bottles of the same period (compare Tables 16-17 with 10-12). In the 1790s the bases decreased in diameter again and the bodies became consistently taller (Tables 20-22, Figs. 58b, 59b). As in the beer-style quarts, each of the modifications made on this style involved a narrowing of the body/base diameters and a lengthening of the body. The changeover periods, when both the older shape and the new shape were in production, were the 1760s and the 1790s.

Bottles with these base diameters and body heights are well represented in North American archaeological contexts.

Undersized Beer-Style Quarts (Fig. 60 and Appendix B, Tables 8, 13-15, 19)

These quarts generally had capacities less than 950 mL but had base diameter to body height ratios consistent with the larger beer-style quarts. At any given time period the base diameters were generally about 10 mm less than the beer-style quarts and about 10 mm greater than the wine-style quarts. The body heights were generally much shorter than the wine-style quarts. The earliest examples (Table 8), dating to the 1740s and 1750s, had base diameters considerably larger than the body heights. The second group (Tables 13-15, Fig. 57a) had three variants. Introduced in the 1750s, it generally had a "square" body, with the base diameters and body heights close to the same value. Beginning in the late 1760s the body height was sometimes greater than the base diameter. The "square" look, in all three variations, continued to be produced until the early 19th century. In the 1790s a third modification was made (Table 19). The bodies were considerably taller than the base diameters but the body style continued to be shorter and wider than the wine-style bottles (Figs. 58, 59). Each of the modifications made in this style involved narrowing the body/base diameters and lengthening the body. The changeover periods, when both the older shape and the new shape were in production, were the 1750s and 1760s and ca. 1790-1810.

The style in question seems to represent a distinct and deliberate variation rather than an accidental one. The range of variability for a desired "look" was wide (compare Table 10 with 12 or 20 with 22) but tended to relate more to body height than to diameter. The body diameter, and to a large extent the base diameter, was controlled by the moulds being used whereas the body height depended more on the bottlemaker's judgment. In 1777 Benjamin Harrison, the London merchant who bought the products of the Hartley Pans factory, complained:

> You have a Mould for your Moulded Quarts which is Something Wider than your other Mould & gives a great deal of Trouble to Sort, when Mixt with the other Bottells, I wish you would be so good to let this Widest Mould be laid Entirely Aside & to Convince you of it I send you the 2 different Bottells by Winters with a Labell about their Necks. I must once more Beg that you will be very particular in attending to this (N.C.R.O. 2DE 11/11/50).

Are these quarts variants of the wine-style or the beer-style quarts? For several reasons it seems logical to consider them variants of the beer-style:

1) For each alteration in the large beer-style quarts there is a corresponding alteration in this smaller size, suggesting that this style is an undersized beer-style. This can be observed by comparing the body height minus base diameter values in the tables. Moreover, the changes occur in the same time periods.

2) The recognized beer-style in the second quarter of the 19th century was shorter and wider than its wine-style counterpart even though many had capacities below 950 mL. Examples of marked Ricketts' bottles of the beer/porter style examined for this study (Appendix A, Nos. 187, 214, 217, 219) had capacities between 750 and 800 mL, well below either the ale/beer or imperial quarts and well above the pint capacity. Wine merchants Barret and Clay noted in 1841 that a common size bottle for ale held 29.5 ounces (838.9 mL) (Great Britain. Parliament. Sessional Papers 1842: 353).

3) The undersized beer-style is well represented in the archaeological collections from Canada, and probably in the United States, but is poorly represented in the sealed and dated sample. The larger beer-style bottle, however, is poorly represented in North American archaeological contexts. We know, however, that ales and porters were regularly sold in bottles in North America. Porter, for example, was a popular drink with British army officers (Jones and Smith 1985) and many of the sites used for comparative purposes in this study were military ones. In the absence of the larger beer quarts these smaller bottles probably served as beer bottles.

There are two possible explanations for the difference between the dated sample and the North American archaeological material. First, the beer gallon may not have been as widely used in North America. Between 1758 and 1799 the Canadian colonies, except for Newfoundland, all officially adopted the Queen Anne wine gallon (Ross 1983: 98). In 1836 this gallon also became the official United States gallon (Skinner 1967: 107). Second, different size bottles apparently were used for different markets. Later evidence suggests that certain markets tended to get the smaller, less desirable bottles (see Capacity).

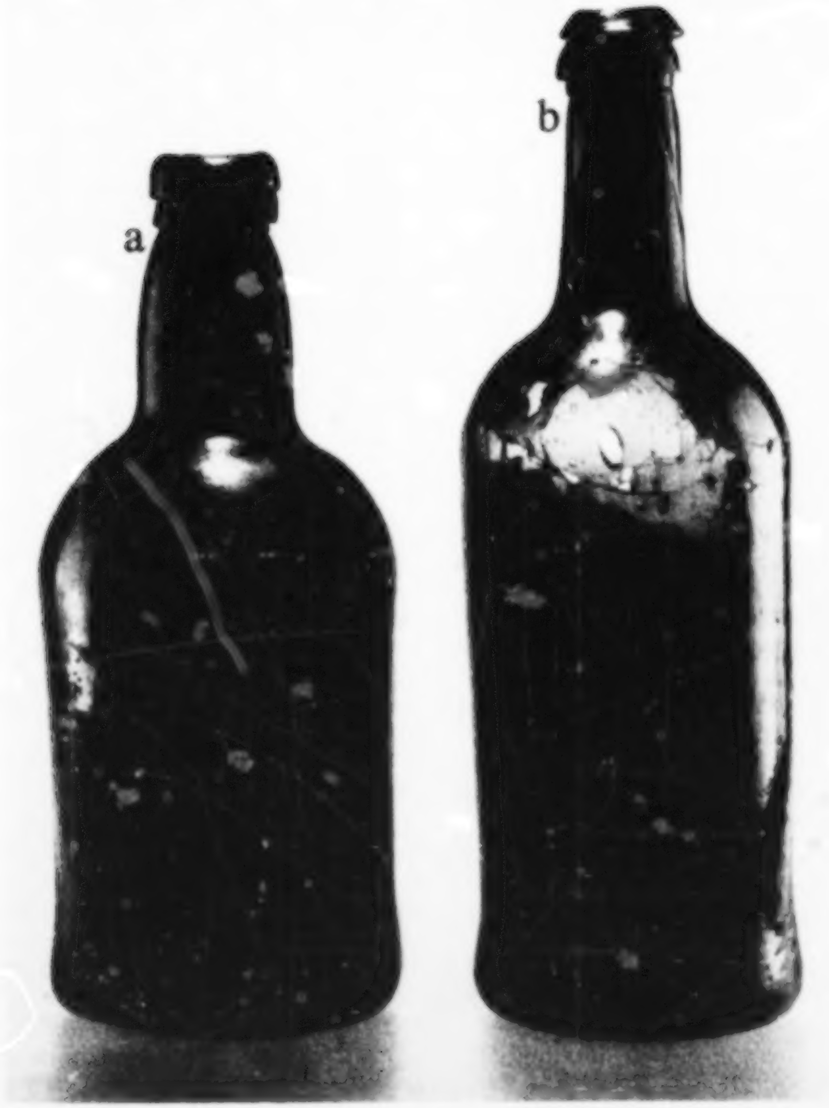


Figure 58. Pair of bottles dating between ca. 1790 and 1820 shows difference between (a) an undersized beer-style and (b) a wine-style quart. a) Bottle height: 231 mm; body height: 118 mm; base diameter: 96 mm; capacity: 765 mm. b) Bottle height: 266 mm; body height: 150 mm; base diameter: 88 mm; estimated capacity: 801 mL. (Photo by R. Chan; RA-14174B)

4) The undersized beer-style could be considered a transitional one for the wine-style. The presence of transitional forms is suggestive of a developmental process in which the body height/base diameter ratios change gradually through time. Transitional forms should gradually disappear as the "final" form becomes established. For example, if the bottles from Tables 13-15 with the shorter wider bodies were predecessors to the tall slender wine-style bottles in Tables 16-17 then they should be replaced

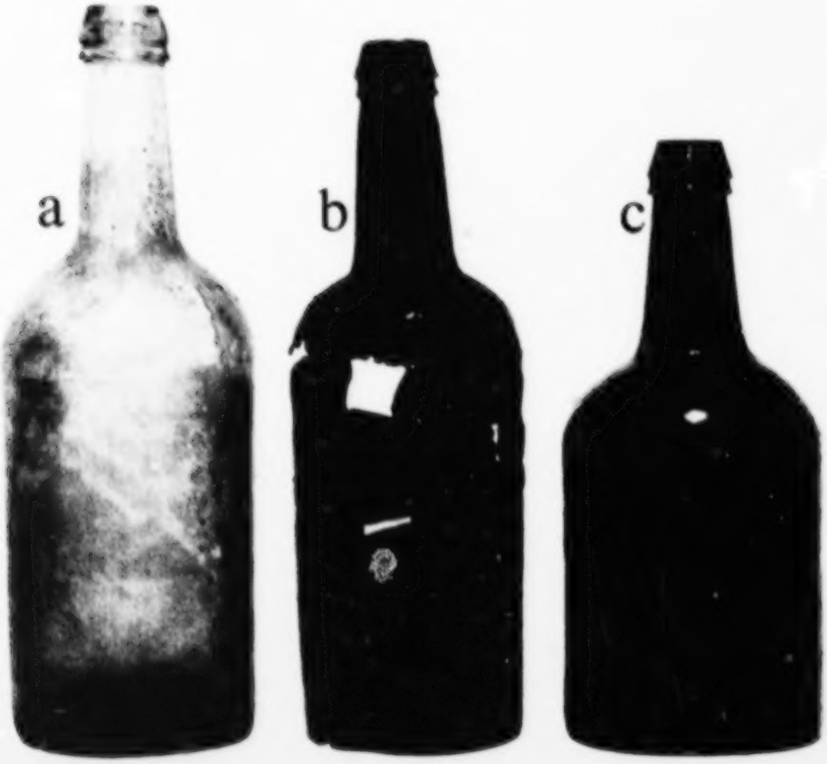


Figure 59. Three bottles dating between 1821 and 1852 embossed with H. Ricketts' company name on the base and PATENT on the shoulder. They represent three styles available in this period. a) Imperial wine-style. Bottle height: 285 mm; body height: 157 mm; base diameter: 89 mm; capacity: 985 mL. b) Wine-style. Bottle height: 271 mm; body height: 152 mm; base diameter: 83 mm; estimated capacity: 698 mL. c) Undersized beer-style. Bottle height: 232 mm; body height: 117 mm; base diameter: 97 mm; capacity: 795 mL. (Photo by R. Chan; RA-12848B)

by the wine-style. However, both styles continue in production from the 1760s into the early 19th century. In fact, the tall slender wine-style seems to have emerged suddenly in the early 1760s without any preliminary forms. The changes in the cylindrical body styles do not seem to occur in a smooth continuous manner but abruptly, in a series of "successively introduced standards" (Robertson 1976: 18).

If these bottles are found in great numbers in English archaeological contexts, I think we will have to re-consider their possible use even though stylistically they are closer to the beer-style than to the wine-style. They may, in fact, be the "commons" mentioned in glass manufacturers' documents and newspaper advertisements.

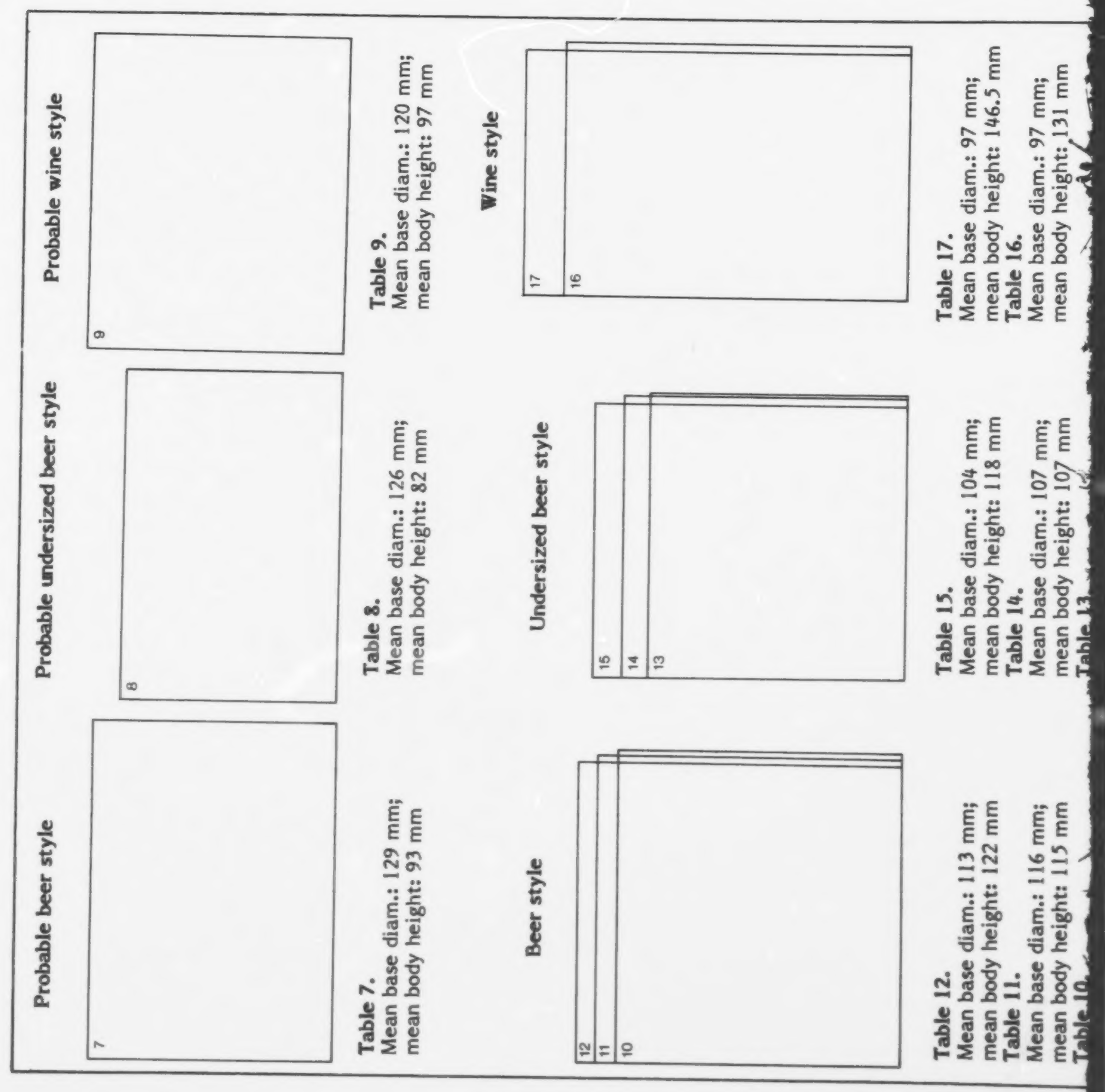
Imperial Wine-Style Quarts (Fig. 60 and Appendix B, Table 23)

After the introduction of the imperial system in 1825, a fourth style of bottle was introduced. The bottles had the tall slender bodies characteristic of the wine-style but had capacities over 950 mL. The Ricketts' bottle in Figure 59 is an example and two embossed IMPERIAL on the shoulder were recorded for this study. I have not looked for examples dating after 1850 so do not know whether this style changed after its introduction.

I have attempted to demonstrate that the cylindrical "wine" bottle was not a single style but that there were, in fact, four distinct identifiable styles produced in the period under study. These styles can be linked to different measurements systems and to their intended contents. I must stress, however, that the two wine-styles and the two beer-styles were not used just for wines and beers. Other products, such as cider, distilled liquors, vinegar, and spa waters would also have been sold in these bottles. The choice of style would probably depend on whether the product in question was customarily measured and sold in the beer or wine system of capacity.

Most complete bottles could be placed easily into one of the styles although a few individual bottles were difficult to classify. It is much more difficult to determine which styles are represented in fragmentary archaeological material. Taking into account the date of manufacture or date of the site, one can use the base diameter as a rough guide. But during the changeover periods (1750-70 and 1790-1810) one needs to have the body heights as well. The same base diameters occurred in more than one style.

Without firm external evidence to identify beer-style and wine-style quarts, the validity of the four styles cannot be differentiated mathematically (Cohen 1983: pers. com.). Nevertheless, I feel that the existence of the four styles explains the variations in size and proportions that were clearly evident in the measurement data.


Probable beer style
7
Table 7.
Mean base diam.: 129 mm;
mean body height: 93 mm
Probable undersized beer style
8
Table 8.
Mean base diam.: 126 mm;
mean body height: 82 mm
Probable wine style
9
Table 9.
Mean base diam.: 120 mm;
mean body height: 97 mm
Beer style
12
11
10
Table 12.
Mean base diam.: 113 mm;
mean body height: 122 mm
Table 11.
Mean base diam.: 116 mm;
mean body height: 115 mm
Undersized beer style
15
14
13
Table 15.
Mean base diam.: 104 mm;
mean body height: 118 mm
Table 14.
Mean base diam.: 107 mm;
mean body height: 107 mm
Wine style
17
16
Table 17.
Mean base diam.: 97 mm;
mean body height: 146.5 mm
Table 16.
Mean base diam.: 97 mm;
mean body height: 131 mm

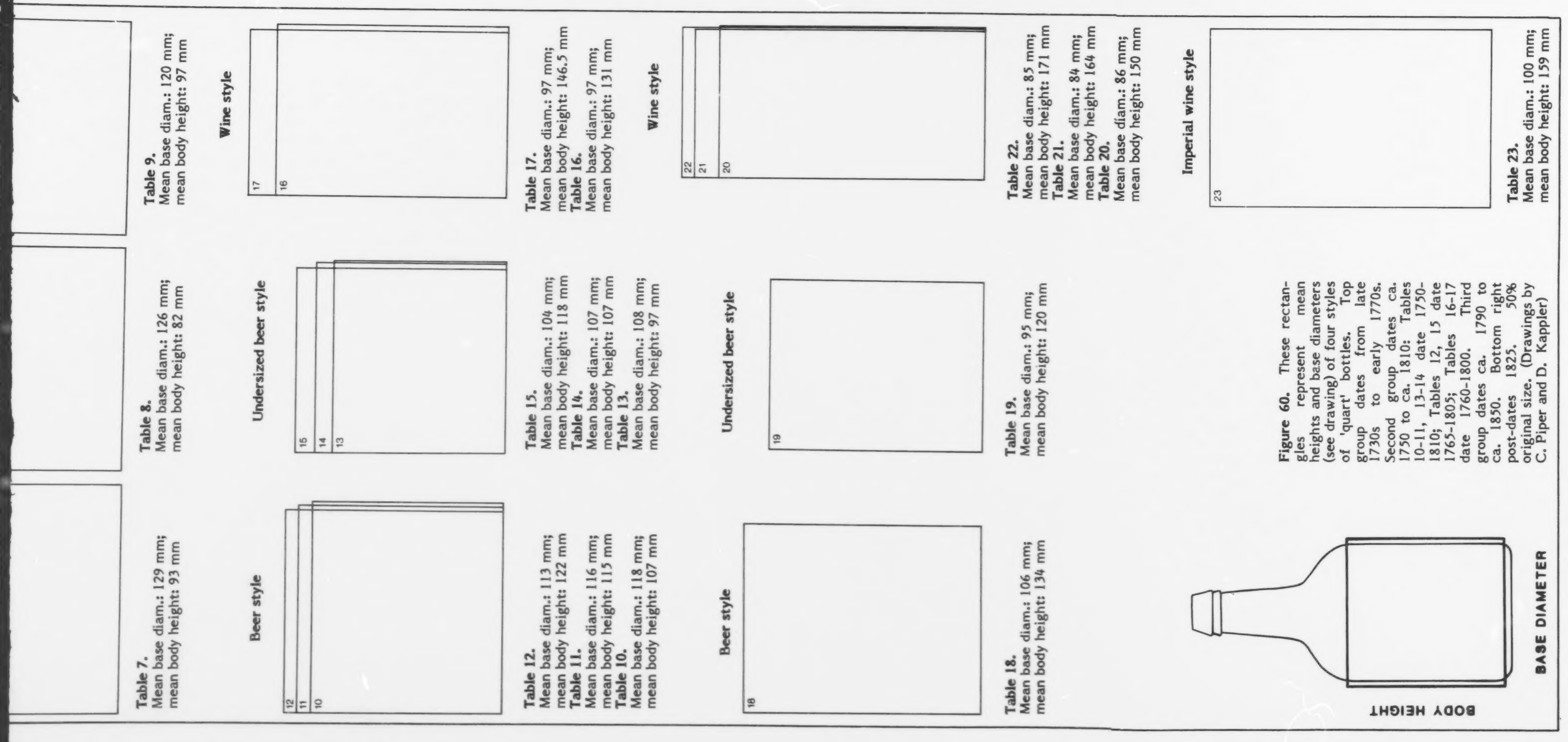


Table 7.
Mean base diam.: 129 mm;
mean body height: 93 mm
Table 8.
Mean base diam.: 126 mm;
mean body height: 82 mm
Table 9.
Mean base diam.: 120 mm;
mean body height: 97 mm
Beer style
12
11
10
Table 12.
Mean base diam.: 113 mm;
mean body height: 122 mm
Table 11.
Mean base diam.: 116 mm;
mean body height: 115 mm
Table 10.
Mean base diam.: 118 mm;
mean body height: 107 mm
Undersized beer style
15
14
13
Table 15.
Mean base diam.: 104 mm;
mean body height: 118 mm
Table 14.
Mean base diam.: 107 mm;
mean body height: 107 mm
Table 13.
Mean base diam.: 108 mm;
mean body height: 97 mm
Wine style
17
16
Table 17.
Mean base diam.: 97 mm;
mean body height: 146.5 mm
Table 16.
Mean base diam.: 97 mm;
mean body height: 131 mm
Beer style
18
Table 18.
Mean base diam.: 106 mm;
mean body height: 134 mm
Undersized beer style
19
Table 19.
Mean base diam.: 95 mm;
mean body height: 120 mm
Wine style
22
21
20
Table 22.
Mean base diam.: 85 mm;
mean body height: 171 mm
Table 21.
Mean base diam.: 84 mm;
mean body height: 164 mm
Table 20.
Mean base diam.: 86 mm;
mean body height: 150 mm
Imperial wine style
23
Table 23.
Mean base diam.: 100 mm;
mean body height: 159 mm
BODY HEIGHT
BASE DIAMETER

Figure 60. These rectangles represent mean heights and base diameters (see drawing) of four styles of 'quart' bottles. Top group dates from late 1730s to early 1770s. Second group dates ca. 1750 to ca. 1810: Tables 10-11, 13-14 date 1750-1810; Tables 12, 15 date 1765-1805; Tables 16-17 date 1760-1800. Third group dates ca. 1790 to ca. 1850. Bottom right post-dates 1825. 50% original size. (Drawings by C. Piper and D. Kappler)

Manufacturing Techniques

Dip Moulds

A dip mould is one in which the object being formed is inserted and extracted through the top of the mould. Although it can be made in more than one piece, the dip mould does not open and shut nor does it close over the top of the object being formed. Dip moulds smaller than the intended size of the finished object are used to decorate the glass. Full-sized dip moulds are used to form part or all of the object to its full size.

In the manufacture of dark green glass "wine" bottles, full-sized dip moulds were used to form the body, and sometimes the base of the bottle. The shoulder, neck, and finish were invariably formed outside the mould. To facilitate removal of the bottle from the mould, the mould generally tapered slightly, widening towards the shoulder. The surface in contact with the mould was often ruffled in some way whereas the shoulder and neck had a smoother, fire-polished surface (Fig. 61). In some examples, particularly in the tall slender versions, the glass at the shoulder sometimes swelled slightly over the top of the mould so that a distinct bulge can be seen.

It is difficult to establish a beginning date for the full-sized dip mould. The regularities of the square bottles dating to the 17th century suggest that this type of mould was in use during that century. For the English "wine" bottles, however, the production of globular-shaped bodies and straight-sided bodies which widened towards the base was incompatible with the dip mould technique. There is some evidence to suggest that dip moulds began to be used for a wider range of products in dark green glass during the 1730s. Bottles having true octagonal and flat octagonal bodies, introduced in the late 1720s, were obviously blown in dip moulds. A series of inventories for the Hoopers Glassworks in Bristol dating from 1731 to 1738 indicates that bottle moulds were introduced into the factory during this period. In 1736 "6 Brass moulds and others" are listed for the first time. In 1737 the entry reads "10 Brass and Iron moulds" and in 1738 it reads "10 Brass & Iron Bottle Moulds." The list of bottles on hand in 1738 is as follows:

7940	doz best cast[?] Quarts
10168	doz ditto Seconds
6150	doz unsorted Quarts
3060	doz measured Pints
225	doz unsizable Ditto
284	doz eight sqr. Ditto
46	doz Ditto Quarts
207	doz three Pints
110	doz flatt Pottles
100	doz Single Gallons

1260 Large Bottles [?] 3144 Gall (Bristol City Museum and Art Gallery 1738)

When the cylindrical-bodied "wine" bottles appeared late in the 1730s, the dip mould became a feasible method for forming the body of these bottles.

Among the dated bottles it was frequently difficult to unequivocably identify dip-moulded bottles. Several examples dating to the 1750s exhibited the characteristic difference between the body and the shoulder but there is every reason to suppose that dip moulds were being used earlier. By 1762 the term "mould" was used to refer to "wine" bottles themselves (see Dark Green Glass Tradition in England). In various documents dating to the 1780s from the Hartley Pans glasshouse, the terms "moulded" and "moulds" were commonplace (N.C.R.O. 2DE).

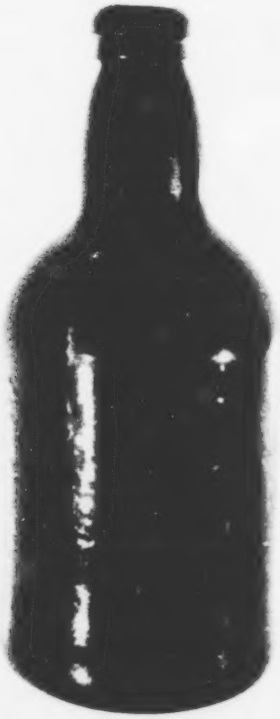


Figure 61. Blown in a dip mould, this bottle has a faint horizontal line at the body/shoulder junction and a difference in surface texture between the moulded body and free-blown shoulder. (Photo by R. Chan; RA-12846B)

Illustrations of the dip mould in use for the production of bottles appeared in the Diderot plates published in 1772 (*Encyclopédie*...1772: Pl. IV) and in a drawing by C.W. Carlberg, dating to 1777-78, of a bottle-glass factory in Gravel Lane, Southward, London (Charleston 1978: 24, Fig. 17). The construction in the London factory is described as follows:

> s. Hål i golvet, varuti butel jerna i deras järnformar blåsas. [There is a hole in the floor, in which hole the bottles are blown in their iron moulds] (Backström, Anderberg and Simmingsköld 1947: 77).

The dip mould continued to be used in the production of "wine" bottles even after the introduction of the three-piece mould in the 1820s. Examples of dip-moulded "wine" bottles have been found without pontil marks, dating their manufacture in the late 1840s or 1850s at the earliest (see Beaudet 1981: 117). The only major change in technique was the formation of the pushup in the mould rather than outside of it. The change was probably attributable to the improved appearance of the Ricketts' bottles which had the pushup formed in the mould. This practice resulted in the virtual disappearance of the basal sag.

By 1865 British bottle-glass factories had stopped using dip moulds, replacing them with the more efficient open-and-shut moulds.

> The time has been gained in different ways. Less time is now taken in the preparation of the metal. The bottle-makers have better implements....The open and shut moulds now in use enable them to make probably a dozen in an hour more than they could with the old open mould, with which the shoulder has to be formed by blowing. They can make now from nine to 10 dozen in an hour. Formerly they made only seven or eight dozen in the same time. (Great Britain. Parliament...1865: 395).

The dip mould was in use for such a long period and its use is frequently so difficult to identify that it is virtually useless as a dating tool.

Three-Piece or Ricketts'-Type Mould

The "three-piece" mould consisted of a cylindrical one-piece mould part which formed the body of the bottle and two open-and-shut mould parts which formed the shoulder and sometimes the neck of the bottle. In addition, there could be a fourth part which formed the base. The characteristic mould lines left on the bottle by this mould are a line encircling the body at the shoulder junction and two vertical lines beginning at the horizontal line and going over the shoulder to the neck (Fig. 62). If a base mould part was used then a circular mould line can usually be found on the heel or resting surface. The finish and sometimes the neck were finished outside the mould by the use of hand-held tools.

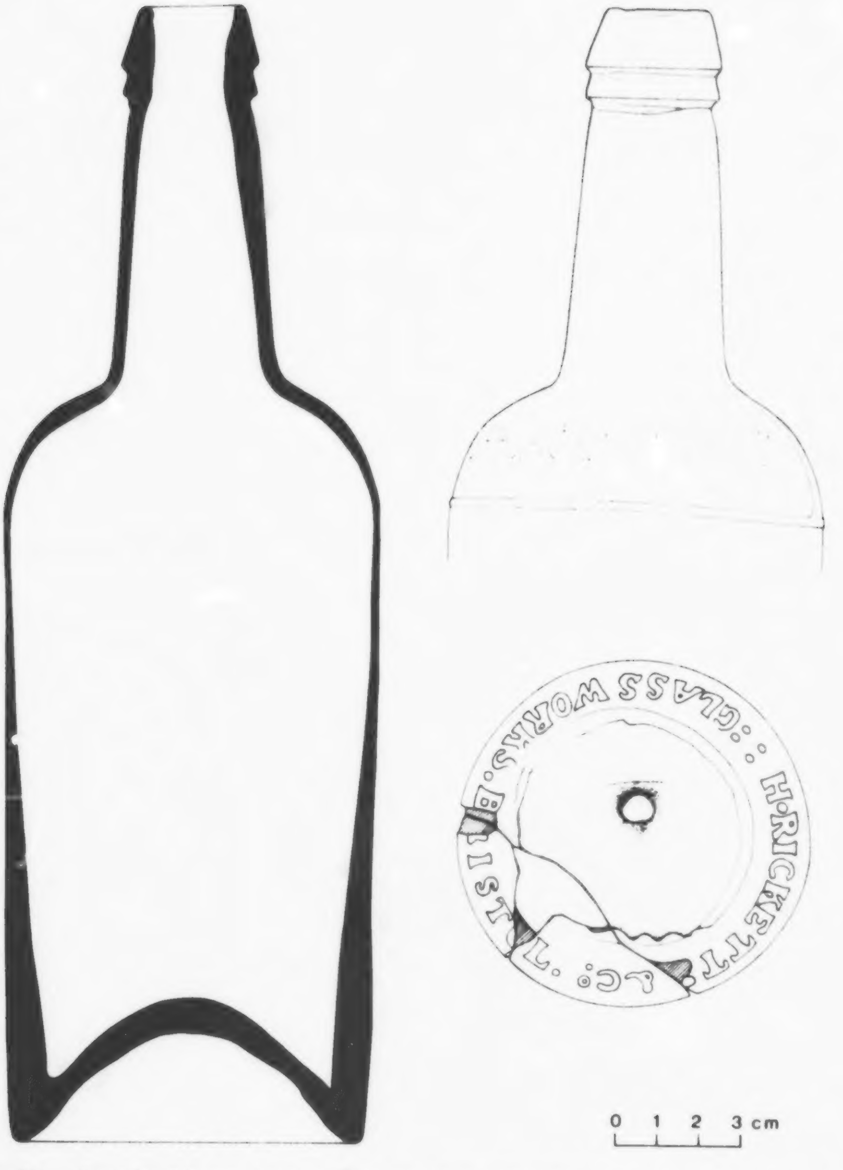


Figure 62. Bottle blown in the Ricketts' mould showing the characteristic mould lines of a "three-piece" mould in the body/shoulder area. The bottle is embossed on the base and shoulder. (Drawings by D. Kappler)

The date of introduction of the three-piece mould is questionable. The first definite evidence is the patent taken out by Henry Ricketts of Bristol in 1821 (Great Britain. Patent Office 1857). Several authors have suggested, however, that a mould of this type was in use before 1821 (Morgan [1976]: 20-21; Ruggles-Brise 1949: 119; Noël Hume 1961: 105; McKearin and Wilson 1978: 14, 216). Because the mould marks left by the three-piece mould are so distinctive that they can be recognized even on fragments, it is worthwhile to examine the dating evidence in some detail.

The earliest possibility is suggested by Morgan ([1976]: 20-21). He states that in 1802 Charles Chubsee of Stourbridge developed an iron bottle-making mould which folded together in three parts and illustrates a mould that would leave the characteristic mould lines of the three-piece mould. The illustration in Morgan is adapted from one appearing in Weiss (Morgan [1976]: pers. com.; Weiss 1971: 323). Weiss states that in 1802 Charles Chubsee of Stourbridge devised "an iron mould which folds together to be opened mechanically." He also states that three-part moulds were developed in 1830. Although the source of the Weiss illustration has not been located, similar types of moulds were illustrated later in the century in Tomlinson (1852-54: Vol. 1, 768) who attributed the mould construction to Apsley Pellatt, a well-known glass manufacturer in London, and in Pellatt's own book (1968 [1849]: 103-4) where he made no such claim for himself. The mould construction in each illustration is slightly different although all three show a "three-piece" mould. The Weiss/Morgan illustration shows the neck being formed in the mould. The earliest dated example that I saw with this feature was a Ricketts' bottle dated 1840 (Appendix A, No. 205). Although the Ricketts' patent stated that the mould could form part of the neck, none of the Ricketts' bottles that I have seen from the 1820s and 1830s have the shoulder mould lines extending much beyond the base of the neck.

Other authors credit Charles Chubsee of Stourbridge with introducing "open-and-shut" moulds for the first time in 1802 (Sandilands 1931: 238; Elville 1951: 218, refers to Charles Chasbie (*sic*); Hughes 1958: 152-53). Hughes (1956: 152-53) indicates that this mould enabled the glassmakers to form the vessel and at the same time elaborately decorate the exterior surface of the glass. Full-size, open-and-shut moulds were not new in 1802. They were used to make stems on stemware from the mid-16th century into the mid-18th century (Jones 1983: 169). Tumblers and lead glass vials dating to the mid-18th century were being made in this type of mould (Smith 1981: 218; McNally 1979: 37, 76; Noël Hume 1969: 43-44). The technology for forming and decorating objects or parts of objects in full-size, open-and-shut moulds had been known and practised in European and British glass factories since the second half of the 16th century.

None of the authors have provided the source for their information but it apparently comes from the *Victoria County History for Worcester* published in 1906:

> In 1802 open and sheet [shut] moulds for pressing glass were first used by Charles Chasbie (*sic*)...(Taylor 1971: 281).

The following reference appears in some manuscript notes written in 1886 by Benjamin Richardson the First:

> In 1814 there was a flint Glass Works built at Wolverhampton and was carried on by Mr. Burkle, and Charles Chubsey (*sic*) was his Manager. Charles Chubsey was very hand in turning patterns.... and also a good mould maker, principally for diamond mould... (Woodward 1978: pers. com.).

Richardson was manager of Hawkes and Company of Dudley and was well known in the Stourbridge area for his pioneering interest in and development of new techniques for decorating glassware (Guttery 1956: 127, 141).

It would seem, therefore, that the Chubsee mould was probably a full-size mould in two or more parts that was designed to impart complicated geometric motifs, modelled on contemporary cut motifs, onto the surface of a variety of tableware forms such as decanters and bowls. This type of ware is familiar to collectors of American glass as "blown-three-mould" but similar types of wares were also being made in the early years of the 19th century in Irish and English flint glass houses (McKearin and McKearin 1948: Pl. 124, Nos. 1-4, 240-331; Warren 1970: 93, Pl. 41D; Thorpe 1961: 234). In the absence of any firm evidence to the contrary, it is unlikely that Chubsee's mould(s) would have been used to make dark green glass "wine" bottles.

Although the Chubsee mould can be discounted there is still some suggestion that the three-piece mould may have been in production before the Ricketts' patent in 1821, either by Ricketts himself or by some other glassmaking firm.

Two undated sealed bottles have been seen which, on the basis of finish styles, could pre-date the Ricketts' mould. One, sealed T. Barns. Wylde-Court (Appendix A, No. 326), does not have a typical English "wine" bottle shape. The body is shorter and slopes outward quite strongly from base to shoulder and has a tapered shoulder. The pushup is deep, bell-shaped, and is not moulded although the heel is abrupt. The shoulder mould lines go up to the mid-point on the neck. The other bottle (Appendix A, No. 327) is sealed with a crest (upon a wreath of the colours a dexter hand couped at the wrist apaumé above HC) attributed to Sir Henry Carew, seventh baronet (1779-1830), Haccombe, Newton Abbot, Devon (illustrated in Dumbrell 1983: 104). Ruggles-Brise (1949: 62) has dated the bottle to ca. 1805, Morgan ([1976]: pers. com.) to ca. 1810. In the example I saw, the two mould lines on the shoulder are clearly visible but the horizontal line encircling the top of the body is not. The shoulder is tapered rather than rounded like the Ricketts' ones. The heel is abrupt and the base appears to have been moulded, suggesting an 1820s date of manufacture. Both bottles could date before 1821 but the combination of conflicting dating elements as well as some uncommon shape features make it difficult to arrive at an unqualified decision concerning the date of manufacture. Both have, however, abrupt heels, a feature that seems to have been introduced by the Ricketts' mould.

The Ricketts' patent (Fig. 66) clearly illustrates and describes a "three-piece" mould although Ricketts did not lay specific claim to it:

> K,K, the cover or upper part of the mould, which is in two parts, and so shaped that on being closed they form the shoulder and part of the neck of the bottle (Great Britain. Patent Office 1857: 3).

Ricketts does imply that the shoulder parts are an integral part of the improvements by claiming that the mould made bottles of regular height, capacity, and shape "which cannot by other means be so well attained." The bulk of the patent deals with the mechanical movements of the mould and the moveable base part (see Heels and Bases), all of which Ricketts was obviously claiming.

The French glassmaker Georges Bontemps (1868: 511-12) described three different types of three-piece moulds, including a Ricketts-type and one in which the shoulder parts were opened and shut by a "boy" rather than mechanically. He commented that in English factories he had seen three workers make 90-100 Madeira bottles an hour using these moulds. Bontemps, manager of the Choisy-le-Roi factory in France, had visited England ca. 1828 and maintained close ties with the window-glass factory at Spon Lane near Birmingham (Barker 1977: 60).

Of the 53 bottles I examined dated between 1800 and 1821, none had been blown in a three-piece mould. Those sealed W. Leman Chard 1771 and another sealed Olmstead 1820 (Wine Companies of Hublein 1977: 100) were blown in the patented mould and clearly date after 1821. Numerous examples of sealed bottles dating after 1822 were blown in Ricketts' moulds or other unmarked three-piece moulds. Undated bottles, such as that in Figure 67, with their combination of basal sag and finishes formed by a finishing tool date to the 1820s or early 1830s.

Based on the present evidence, the 1821 Ricketts' patent has to be considered the first concrete evidence for the use of the three-piece mould but it is obvious from Bontemps comments and from other extant examples that other types of three-piece moulds, less mechanically sophisticated, were in use in English factories in the 1820s.

HEELS AND BASES

Heel

The heel is the point at which the body curves into the base. Three heel shapes were observed on "wine" bottles. The first shape was rounded, the straight body line gradually curving into the pushup (Fig. 65a). The second was bulged, the lower part of the body swelling outward before curving into the resting point (Figs. 65b, 66a). The third was abrupt, the lower body turning sharply into the base so that the resting surface is pointed rather than rounded (Figs. 65c, 66d). The rounded heel was common from the introduction of the cylindrical body form and continued into the 20th century. The bulged heel, with "basal sag," was common on the mallet-shaped "wine" bottles and continued to be evident on the cylindrical form until the 1820s. Of the 25 dated bottles between 1821 and 1858 only two, both dating to the first half of the 1820s, exhibited basal sag. Other examples from archaeological contexts with three-piece mould lines and with finishes formed by finishing tools (Fig. 64) suggest that the bulged heel continued to at least the end of the 1820s. The abrupt heel first appeared on examples dated 1822 and continued into the 20th century. At the same time very uneven resting surfaces began to disappear. Both the bulged heel and the abrupt heel are caused by the manufacturing techniques used to form the base.

Pushup

The majority of the dated bottles had dome-shaped pushups (Fig. 66a, b) with only a few examples having conical pushups (Fig. 66c, d), generally dating after ca. 1790. Conical shapes are much more common in the archaeological material, particularly from the late 18th century onward.

Forming the Heel and Pushup

The pushup is formed while the bottle is still attached to the blowpipe but before the pontil is applied or the snap used. Using evidence left on the bottles and historic descriptions of manufacturing processes, I

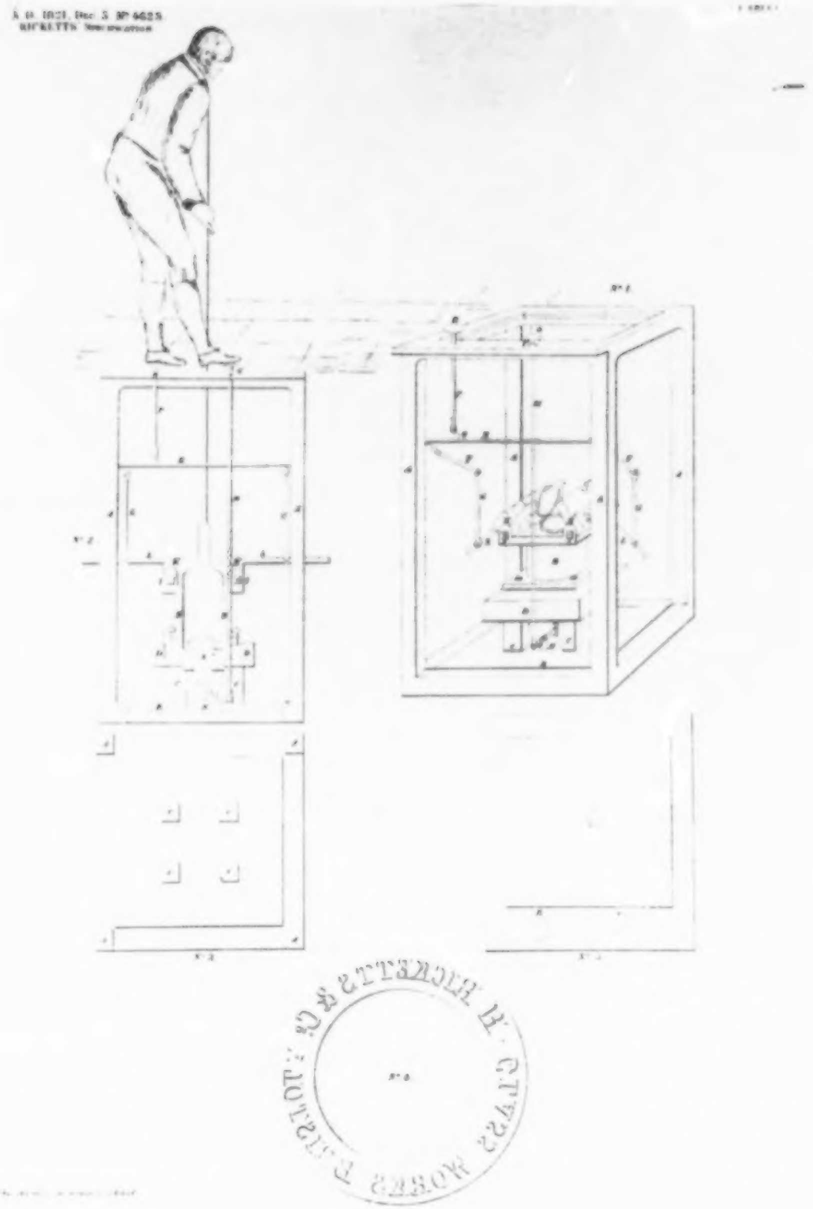

H. RICKETTS & CO. GLASS WORKS BRISTOL

Figure 63. The drawings accompanying the Ricketts' patent specification show the various parts of the mould and its operative movements. (Great Britain. Patent Office 1857. Photo by R. Chan; RD-869M)

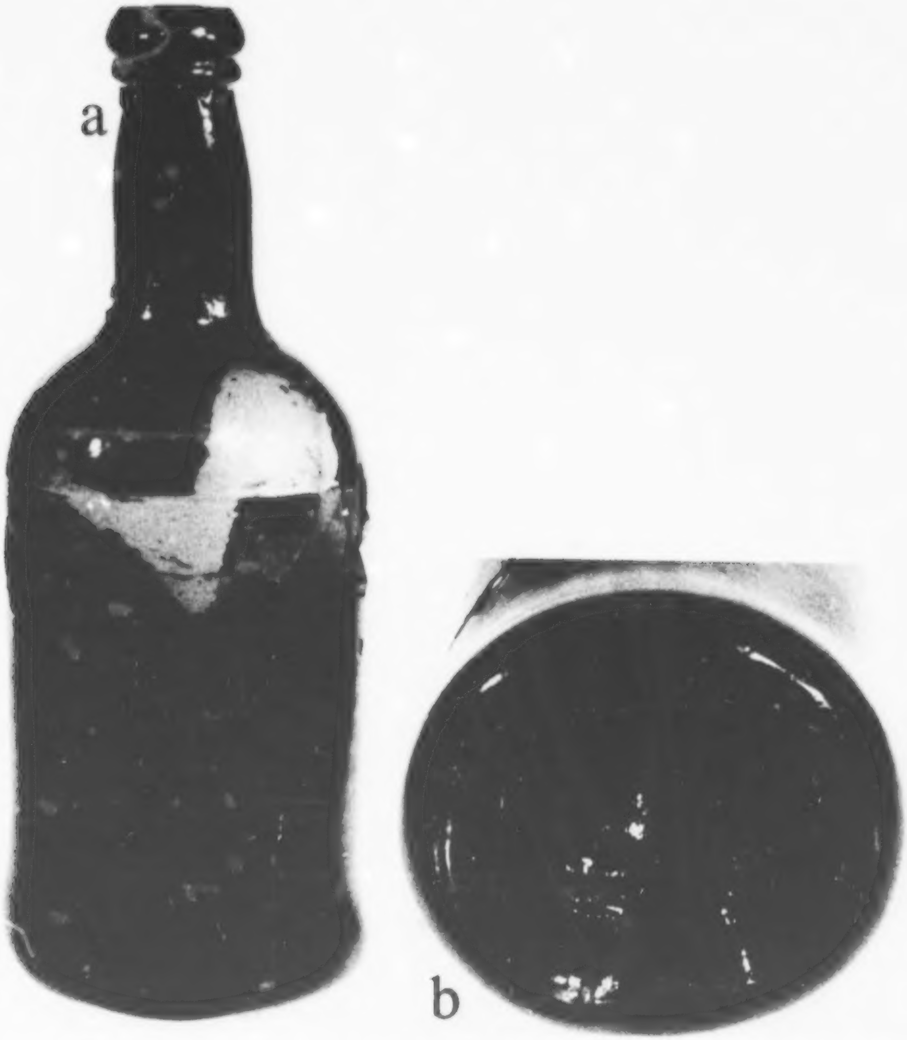


Figure 64. Blown in a three-piece mould, this bottle has a distinctive finish shaped by a finish-forming tool, a distinct basal sag, and a mould line on the heel (b). Based on the latter two features the bottle dates to the 1820s or early 1830s. (Photos by R. Chan; RA-12737B; RA-12733B)

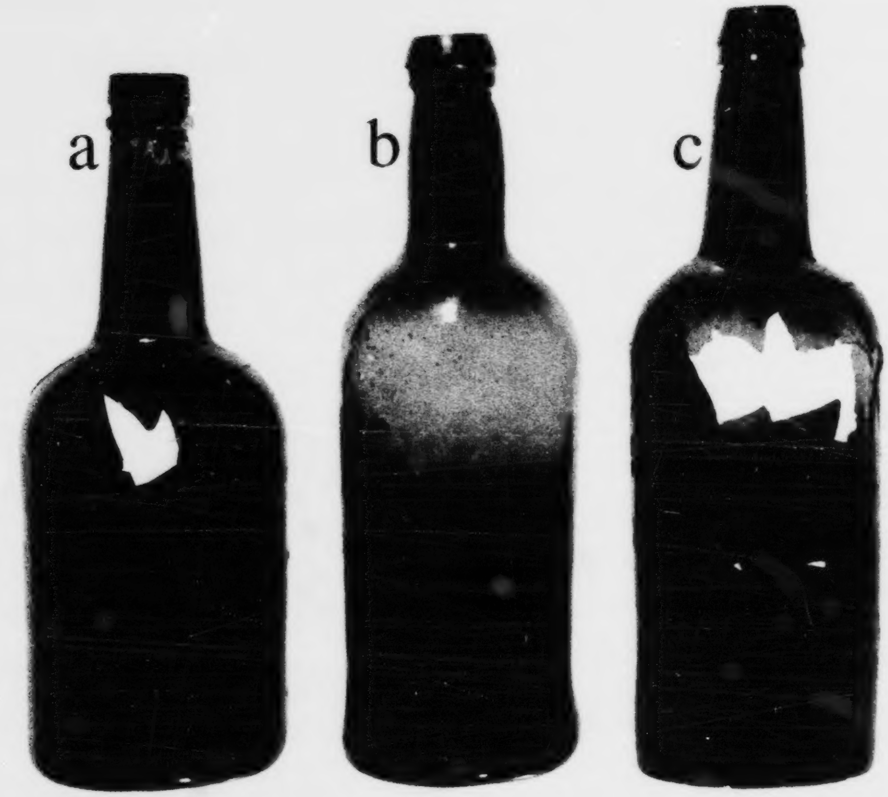


Figure 65. a) Rounded heel; b) bulged heel; c) abrupt heel. (Photo by R. Chan; RA-12809B)

have identified several different pushup-forming tools (Jones 1971: 63-68). A bewildering array of marks left by these tools were observed on bottles from archaeological contexts, and on the sealed and dated bottles. In the tip of the pushup are rounded protrusions, circular, trifoil, quatrefoil, cinqfoil, and sixfoil, square, dome-shaped, X-shaped, and pointed impressions, iron-oxide deposits of trifoil, quatrefoil, circular, and indeterminate shape, and combinations of the deposits and the impressions. Also to be observed are ridges resembling mould lines (Fig. 66d). Many examples bear no visible evidence of the type of pushup-forming tool used. Of those bearing recognizable marks, the quatrefoil-shaped impression occurs most frequently. The earliest sealed bottle I have seen with one was dated 1714

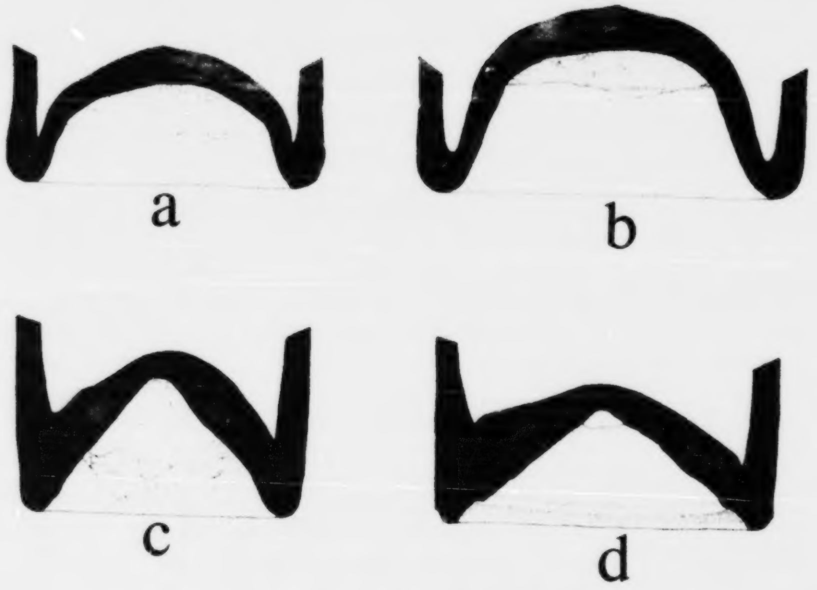


Figure 66. All four bases have sand pontil marks. a) Dome-shaped pushup, bulged heel; b) dome-shaped pushup, rounded heel; c) conical pushup, rounded heel; d) conical pushup, abrupt heel. In (d) a mould line encircles the bottle on the lower body, a mould-like ridge occurs partway up the pushup, and a distinct dome-shaped impression occurs in the tip of the pushup; the glass distribution is extremely uneven. This type of pushup dates to the second quarter of the 19th century and later. (Drawing by J. Moussette)

and the latest one was dated 1826. Until the 1820s most of the pushup-forming tools appear to have been hand-held. There is no evidence to suggest that one can use the shape or size of the marks left by these tools to assist in dating the English "wine" bottle.

When the Ricketts' mould was introduced early in 1822, however, the formation of the pushup appears to have changed. An integral part of the Ricketts' mould was the formation of the pushup in the mould, giving the Ricketts' bottles a regularly formed pushup with the potential for embossed lettering (Fig. 63). In his patent specification Ricketts laid specific claim to the movable base part:

> The act of treading upon the mushroom-shaped cap of M, marked O, so raises the knocker-up N against the punty S under the mould,

> as to produce the concavity usually formed at the bottom of the bottle, and which by this my Invention effectually secures a symmetry of shape (Great Britain. Patent Office 1857: 3).

By forming the base in the mould Ricketts largely eliminated the basal sag and apparently also introduced moulded bases into the production of "wine" bottles (Jones 1983: 171-72).

The base part of the Ricketts' mould consisted of a removable washer which could carry lettering (Fig. 63) and may have been stationary and a mechanical "punty" which formed the pushup and moved up and down during the blowing process. Mould lines encircle the heel or resting point and also occur at the join between the washer and the "punty." The washer could be left plain, be removed altogether, or be made of different thicknesses so that different sizes of bottles could be produced. These sizes probably related to the variations visible within the wine- or beer-styles (Tables 19, 20-22), not to major differences in capacity. In the early years Ricketts attempted to emboss the centre of the base as well (Fig. 67b, c) but with mixed success. The embossing is faint, partly from the application of the pontil and partly because the mould part moved during the blowing process. Ricketts' bottles dating to the mid-19th century consistently have the embossing in the centre of the base (Fig. 67e-i). By this time, however, the base mould part apparently was stationary; the pushup is shallow, the glass distribution tends to make a flat interior surface, and the embossed letters are crisp and well-formed.

Ricketts did not introduce embossed lettering on the base (McKearin and Wilson 1978: 216). Several flint-glass factories in Ireland, dating from the late 18th century, embossed company names on the bases of decanters and other tableware items (Warren 1970: Figs. 9a, 16b). Also, many case bottles dating to the mid-18th century have embossed markings on the basal surface (Noël Hume 1961: 106; Harris 1979: Figs. 5-7). As long as the base was included in the mould and the basal indentation was shallow, it was technically feasible to emboss the bases of vessels blown in dip moulds.

Other references to base-forming techniques in the 19th-century literature do not provide sufficient detail to reconstruct the process or the tools:

> ...the bottom in the mould [dip mould] is of this shape [Fig. 68], and it is pushed in afterwards by means of a conical mould... (Great Britain. Parliament. Sessional Papers 1842: 353).

This is the earliest reference located to date that describes a round-bottom mould. Moulds of this type were used successfully later in the 19th century, particularly for champagne bottles (Henrivaux 1897: 474-76, Pl. XXVII, Figs. 3,6). The round-bottom moulds had an advantage over flat-bottom moulds in that they would have given better glass distribution in the basal area and made deep pushups easier to make in bottles of narrow circumference. In the child labour investigations of the 1860s several glassmakers mentioned improvements in forming the bases:

> The amount of work turned out in a week has much increased from what it was formerly here [Glasgow], and is in parts of England. This is partly owing to mechanical causes, such as the open and shut, instead of the simple open, mould, and a mould in which the kick at the bottom is formed by the putter up, instead of by the finisher at the marver (Great Britain. Parliament. Sessional Papers 1865: 403).
>
> Time has been gained of late years by the use of more complete moulds, and of saucers to form the bottom of the bottles... (Great Britain. Parliament. Sessional Papers 1865: 406).
>
> Wetting off is the lowest stage of work at which a boy is taken as apprentice. He takes the bottle from the blower, saucers it *i.e.* puts it in a mould to indent the bottom, cuts the neck to the right length, and gives it to the finisher (Great Britain. Parliament. Sessional Papers 1865: 407).

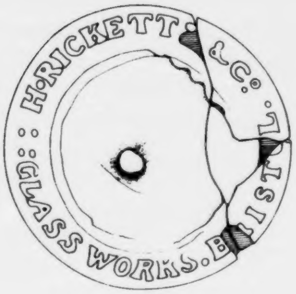
From observations made on bottles of the ca. 1820-50 period, these methods resulted in more regularly shaped pushups and the disappearance of the basal sag.

The shift from the bulged heel to the abrupt heel apparently was caused by a change in technology and a change in taste. Two possible explanations for the basal sag have been offered. Hughes (1955: 1576) suggests that it was caused by "withdrawing the bottle from the metal mould before the glass had cooled sufficiently to bear its own weight, so that it collapsed slightly." Hughes goes on to say that the problem had been cured during the 1770s, which is clearly not the case. Toulouse (1972: pers. com.) suggested that the bulge resulted when the pushup was formed outside the mould after the removal of the bottle from the mould, and that bottles that had the pushup formed while still in the mould did not have the bulge. Two French authors, writing almost a century apart, in describing the manufacture of bottles, support the latter suggestion.

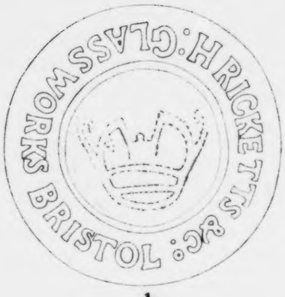
> Maître occupé à rouler sur le marbre le ventre de la bouteille pour lui donner la forme après lui avoir enfoncé le cul (Encyclopédie... 1772: Planche V, Fig. 2).
>
> ...il comprime le fond plat de la bouteille avec un crochet en fer; la bouteille étant roulée de nouveau sur le marbre pour reprendre la forme régulière qu'elle a pu perdre par la confection du fond... (Peligot 1877: 301).

Although French bottles of the 18th and early 19th centuries generally do not have basal sag (Alyluia 1981: 31-55; Ducasse 1970: Figs. 1-5), innumerable examples of English bottles of the same date have bulged heels, suggesting that the English did not bother to reshape the lower body of the bottle after the pushup was made.

The general observations made during the course of this study indicate that Toulouse's suggestion is more likely. Bottles made in the Ricketts' mould, for example, almost invariably had rounded or abrupt


H·RICKETT &Co
GLASS WORKS.BRISTOL

a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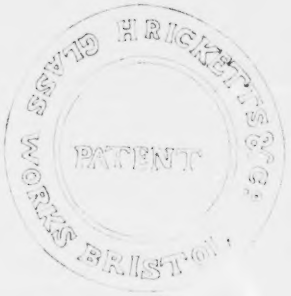
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PATENT

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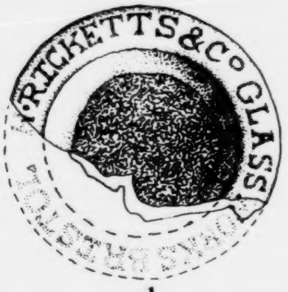
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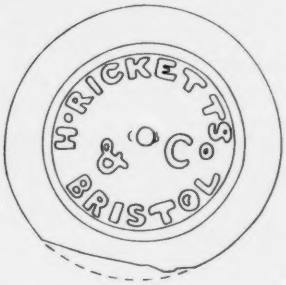
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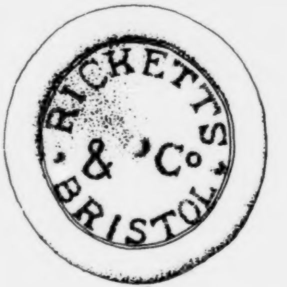
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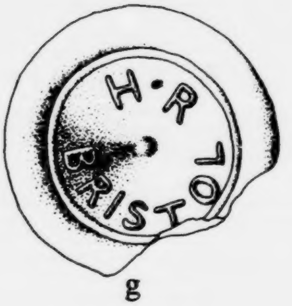
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BRISTOL

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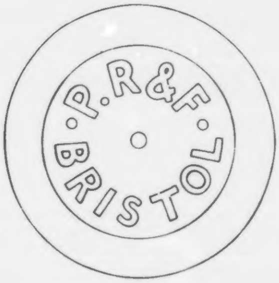
P.R&F
BRISTOL

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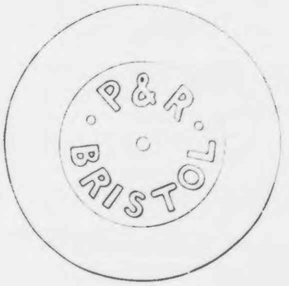
P&R
BRISTOL

i

←**Figure 67.** Dating the base markings of the Ricketts' company bottles (Jones 1983: 176-77). a) The embossing occurs in two rows, as in the patent specification and in bottles dating to the 1820s and possibly into the early 1830s, although no dated bottles from 1830-35 were seen. b) The embossed crown in the centre seems to occur on bottles with IMPERIAL embossed on the shoulder. These date after 1 May 1825 when the imperial system came into effect. c) Examples with PATENT embossed in the centre of the base probably date close to the patent date. d) Examples with the embossing in a continuous circle date at least as early as the late 1830s. The style was used by American firms imitating Ricketts' bottles. e) The embossing was moved to the centre of the base when the firm stopped using pontils, probably in the late 1840s. At Henry Ricketts' retirement in 1852, the firm's name changed to Richard Ricketts and Co. (G. Langley 1981: pers. comm.). f) Although the letter H has been omitted this example probably pre-dates (g) as the trend was to increased simplicity in the embossed company marks. g) The name of the firm has been reduced to initials, a style favoured in the 1850s. This marking pre-dates 1852, the year in which Henry Ricketts retired. h) From 1854 to 1857 the firm was known as Powell Ricketts and Filer (G. Langley 1981: pers. com.). i) From 1858 to 1923 the firm was Powell and Ricketts. PATENT continued to be embossed on the shoulder of most of the previous examples. (a-c, e, h-i drawn by D. Kappler; d, f, g drawn by M.H. Smith)

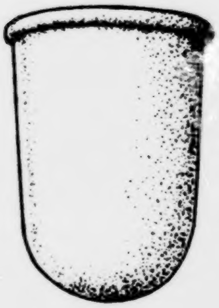

Figure 68. The base profile of a dip mould used for making "wine" bottles. (Great Britain. Parliament. Sessional Papers 1842: 353. Drawing by D. Kappler)

heels. Other bottles, having a mould line on or near the resting surface also generally did not exhibit signs of basal sag although there are some exceptions (Fig. 64). I think that the "superior neatness of appearance" of the Ricketts' bottles rapidly made the bulged base unacceptable to consumers and that even glassmakers still not making the pushup in the bottle mould had to devise a way of eliminating the bulge (Jones 1983: 171-75). The descriptions given previously of the "saucering" technique suggest that it may have been done outside the mould and that the pushup-forming tool was a type of mould. It may, therefore, have also included a portion covering the lower part of the body to control any potential bulging.

One cannot discount Hughes' explanation entirely. One of the dated Ricketts' bottles (Appendix A, No. 193), for example, did have a slight swelling in the lower body but the actual resting point was sharp and well-defined. Toulouse (1973: pers. com.) pointed out that very thick and heavy bases remain fluid after the rest of the bottle stiffened. On its way to the annealing arch, the bottom begins to lengthen and then settles slightly when placed in the arch. One of the characteristic features of the "moulded" bases is their often extremely poor glass distribution in the basal area (Fig. 66d). The outward swell observable on some of these lower bodies can probably be attributed to settling in the annealing oven. The excessive glass thickness is usually only observable in broken examples.

A localized bulge was also sometimes caused by a rod, inserted into the bottle, which was used to carry the bottle to the annealing arch. The bottle was held in an inverted position. The tip of the rod appears to have frequently lodged at the body-base junction, causing a small indentation on the inner base or body-base surface (Fig. 69) and sometimes a corresponding swell on the outer body wall. It has been difficult to establish a date for this practice as the indentation is impossible to see on complete examples. It does tend to occur, however, on the "moulded" bases.

> The children and young persons in the flint and bottle glass works are employed in carrying the finished article on the end of a stick and depositing it in the annealing place (Irish University Press 1968: Vol. II, M 36).

Mason, in his famous 1858 patent, described the use of the rod:

> The bottle or jar, as is well known by glassblowers, is taken out of the mold before it is cold. This is done by the use of a rod, which is run into the bottle or jar, and its outer end is supported by the neck of the bottle, in the ordinary way. As the glass is still plastic the neck will often be slightly distorted, so far as its roundness is concerned, by the weight of the rod resting against the interior of the neck of the bottle or jar (United States. Patent Office 1858: No. 22, 129).

The distortion in the lip area described by Mason has not been particularly noticeable in the dated "wine" bottles. It is practically impossible to link the two features together as the bases and necks of the archaeological sample can rarely be assigned to the same vessel with absolute certainty

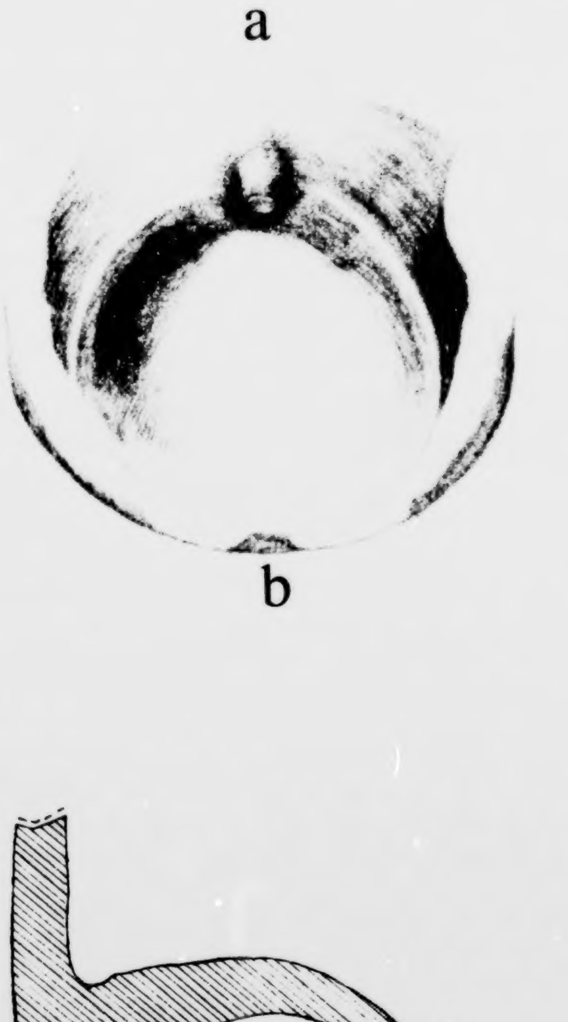

Figure 69. A small indented mark observable on the interior of the body-base junction appears to have been left by the rod used to carry the bottle to the annealing chambers. (Drawing by J. Moussette)

and the interior indentation is impossible to see on complete bottles. Illustrations of the technique appear in Moser (1969: *Tafel* 3) in an interior view of a European glasshouse of the 1770-80 period, and in Kendrick (1968: 168) in a contemporary Mexican glasshouse. Other techniques were also used to carry glass vessels to the annealing oven but generally the object was supported by the base or side on a fork-like tool or a flat board.

Pontil Rod and Snap

During the process of forming a bottle by hand methods (provided the bottle requires finishing while the glass is still in the plastic state), the bottle must be held by the base in some manner while the finish is being shaped. The two tools used during the 1735-1850 period were the pontil and the "snap" (Figs. 70-71).

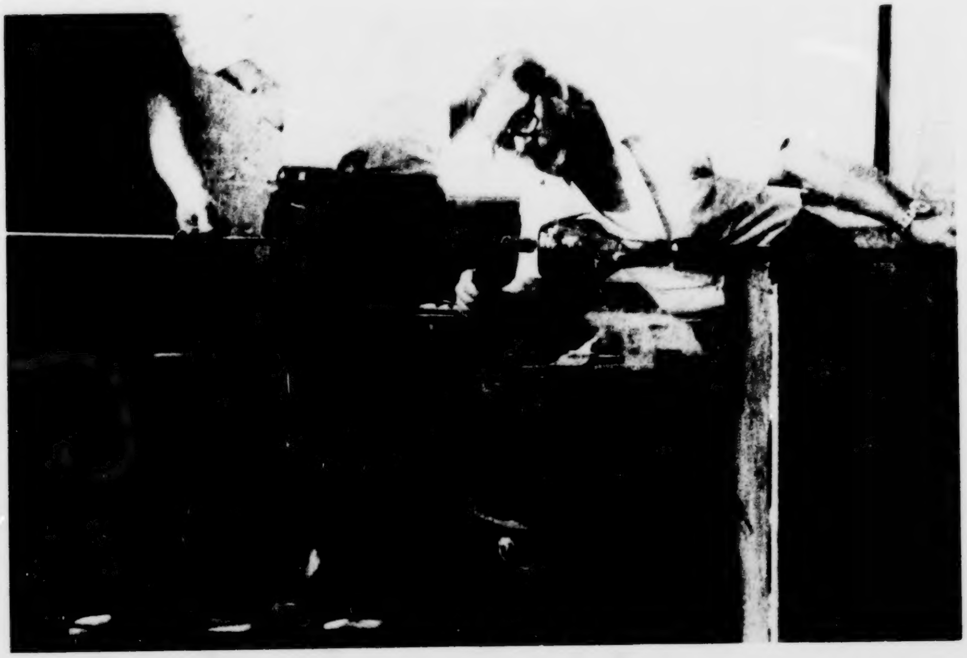

Figure 70. To form the finish of a bottle, the bottle is held at the base by means of the pontil rod. The glass on the end of the rod leaves a distinct mark known as a pontil mark. (Chalet Glassworks, Cornwall, Ontario. Photo by O. Jones; RA-3599M)

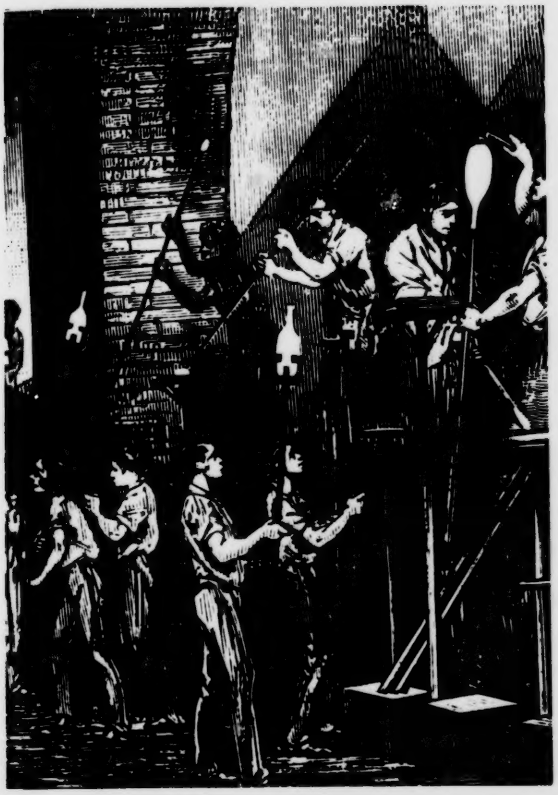

Figure 71. The snap or *sabot*, introduced sometime in the 1840s, replaced the pontil and left no mark on the base of the bottle. (Peligot 1877: Fig. 47. Photo by G. Lupien; RD-245M)

Several different empontilling methods, each of them leaving a slightly different mark, were used in the glass industry during the 18th and 19th centuries (Jones 1971: 68-72; Toulouse 1968). The pontil marks found on the dark green glass English "wine" bottles were, almost without exception, those left by the sand pontil method. In this method glass is gathered on the end of an iron rod; the tip of the glass is shaped to conform to the pushup profile, is dipped in sand, and is then applied to the base of the bottle. The sand keeps the pontil glass from adhering too closely to the bottle but to compensate the connecting surface of the pontil glass is generally larger than in other empontilling methods. When the sand pontil is detached it leaves behind a large circular mark with bits of glass or sand embedded in the pushup (Fig. 66). The large sand pontil mark is so characteristic of the dark green glass English "wine" bottles that the presence of any other type of pontil mark found on this type of bottle should lead one to re-examine the bottle's other features and to reconsider the attribution.

Shortly before 1850 the pontil rod began to be replaced by a tool that held the bottle around the lower body (Fig. 71). If properly used this tool, known as the snap, snap case, spring punty, *sabot*, and so on, left no visible traces of its use on the bottle.

The presence or absence of a pontil mark, indicating the use of either the pontil or the snap, has long been considered a useful dating tool. Unfortunately, in spite of diligent searching I have not been able to establish a precise date for the introduction of the snap. Apsley Pellatt, in his book published in 1849, described and illustrated its use in the production of lamp chimneys:

> A machine is sometimes used instead of a post; this machine is usually a sort of spring cradle at the end of an iron rod, which clips the chimney two to three inches from the bottom, avoids the use of the Glass disk, and prevents the ragged edge, but it is apt to ovalize the chimney; it is not, therefore, much used in Glass Factories (Pellatt 1968: 95).

Another author, reminiscing about his years in the glass trade during the 1839-57 period, described the difficulties encountered by glassmakers trying to use the new tool.

> In several works, thought then to be up to date, phials and other small bottles were even in 1850 made with a punty or pontil, and the bottoms required to be chipped, the instrument used being chisel-shaped; and work was found in the warehouse for chippers. When punty rods, fitted with a small socket and springs were introduced, they were not at all liked at the works where I was employed at the time: that is, not by the men. After a time the use of springs was discarded, better work was turned out, but it was some time ere the glassmakers took kindly to the new method (Recollections of the Flint Glass Trade...1899: 1 April, 462).

Several bottles from the Ricketts factory in Bristol also attest to the use of some type of snap in the English bottle industry by the very early 1850s at the latest. Examples without a pontil mark and embossed H.R. BRISTOL were recovered from the *Niantic* in San Francisco (Fig. 70g; M.H. Smith 1979: pers. com.) and are reported in the literature (Noël Hume 1961: 101; McKearin and Wilson 1978: 217-18). As the firm became Richard Ricketts & Co. in 1853 (Langley 1981: pers. com.) those marked H.R. BRISTOL must date earlier than that.

A group of bottles from an archaeological context dating between 1835 and the early 1850s (Beaudet 1981: 117) had 20 out of 45 bases present with no pontil marks. The unempontilled bases occurred in all ten of the different functional categories identified, such as mineral waters, different liquor types, oils, sauces, and medicines, suggesting widespread use of some type of snap by the early 1850s.

Two sources have suggested that the snap may have been in use in England as early as the 1830s. Talbot (1974: 39) records an egg-shaped mineral water bottle embossed Ray/Soda Water Manufacturer/Greycoat Place/15/Westminster that does not have a pontil mark on its rounded base. Based on directory entries the bottle dates between 1833 and 1839. As the bottle has a tooled lip, the absence of a pontil mark suggests that some type of snap was used. Toulouse (1968: 204) writes that Bontemps says that a tool of this type had been in use in the English factories in the 1830s. However, I was not able to locate this statement in the section "Travail ou Soufflage" nor in the rest of the bottle section nor in the "crystal" section of Bontemps' book. A rather garbled version of Toulouse appears in Munsey (1970: 48) and is repeated in Morgan ([1976]: 28; 1976 pers. com.).

Ducasse (1970: 395, 397, Figs. 2, 3), having studied bottles preserved at the Château Lafite at Pauillac, has suggested that some type of *sabot* (snap) had been used in the manufacture of French wine bottles as early as 1810. He appears, however, to have based this date on the date of the wines contained in the bottles. Because of ullage, potential problems with the corks, and sediment, one cannot assume that the date of the wine and the date of the bottle are the same. It is entirely possible that old wine had been put in new bottles. For example, one of the sealed bottles that I saw bore a label that stated it contained Lenox Madeira "Put in Demijohn, — October, 1805. Bottled, — March, 1816. Re-Bottled, — June, 1888." In this particular instance the date of the bottle itself was compatible with the date of the first bottling. Ducasse (1970: 394) also appears to have difficulty recognizing pontil marks other than blow-pipe marks. His description of a pontil mark as a button of glass, rounded and soft to the touch better describes the large mamelon frequently found in the base of French wine bottles of the second half of the 19th century, and indeed he did find these marks as late as 1914. The "smooth" bases he found, bearing neither the blowpipe mark nor the "button of glass," dating from 1810 to 1834 (Ducasse 1970: 395) probably had the smoother, less obvious sand pontil marks.

The date of the introduction of the snap to replace the pontil can definitely be placed in the 1840s and possibly as early as the late 1830s, although the latter date is based solely on the evidence of one bottle. For the English "wine" bottles the number of dated examples from the 1830s and 1840s has been so limited that no further conclusions can be drawn.

The introduction of the snap did not immediately replace the use of the pontil. The pontil continued to be used into the second half of the 19th century, but for a gradually diminishing range of wares. Bontemps (1868: 511) and Powell (1883: 85), both of them active glassmen, still mention the use of the pontil in the manufacture of bottles. An anonymous author writing in 1894, after describing a spring "snap," goes on to say

> This tool enables the workman to do away entirely with the troublesome "sticking up" of the bottle to the punty with hot glass, though the older method is still practiced in some branches of the industry (National Bottlers Gazette 1894: 88).

Except for some European liquor bottles, certain food storage containers such as olive oils, and large bottles such as demijohns, most bottles found in North America dating after about 1870 do not have pontil marks.

CAPACITY

Glassmakers of the 18th and first half of the 19th centuries had for sale half-pint, pint, quart, pottle, Scotch pints, gallons, and ale quarts and pints. The capacities suggested by these terms are, however, less exact than they might seem. Capacity measures for the bottles used in this study show clearly that the actual capacities for any one of the size terms, particularly quarts, varied to an astonishing degree. There are three reasons for this. First, there were several official liquid capacity measures in use in Great Britain during the period in question. Second, in hand manufacture the range of variability around a desired size is much greater than it is with bottles of machine manufacture. Third, partly through necessity and partly through custom, wine merchants and others habitually used bottles whose capacities did not correspond to official measures.

Several official British liquid capacity measures were in use in the 18th and first half of the 19th centuries. The ale/beer gallon, pre-dating the mid-17th century, contained 282 cubic inches and was intended for ale, beer, and vinegar (Moody 1960: 58-59; Rees 1819: Vol. 15, Gallon). The Queen Anne wine gallon, legalized in 1706, contained 231 cu in. and was apparently intended for use in the wine, cider, spirits, oil, milk, and apothecary trades (Moody 1960: 59; Rees 1819: Vol. 15, Gallon). The Scotch pint, in use throughout the 18th century, contained ideally 105 cu in. but in practice held only 103.404 cu in. (Encyclopaedia or a Dictionary of Arts 1798: Vol. 10, 720; Blunt 1851: 382; Zupko 1977: 151). A Scotch ale pint, dating to the late 18th century, contained 111.6 cu in. (Moody 1960: 64). The Irish gallon legalized in 1695 contained 272.25 cu in. and the one legalized in 1736 contained 217.6 cu in. (Moody 1960: 64). The official capacities were generally multiplied or divided by 2, 4, 8, 16, 32, etc. to arrive at other capacities within the same system (Ross 1983: 42-50). Table 24 shows the divisions as they would apply to glass bottles. In addition to the official measures, older local measures continued to be used.

All of the above systems were replaced, at least in theory, by the imperial standard gallon legalized in 1824 but effective 1 May 1825. The imperial gallon contained 10 pounds avoirdupois weight of distilled water and was intended to be used for all sorts of liquids including wine, beer, ale, and spirits and for dry goods not measured by heaped measure (Great Britain. *Laws and Statutes.* 5 Geo. 3, cap. 74, s. 6).

The imperial gallon was close to the beer gallon because the legislators felt there would be less prejudice against it:

> ...whereas any alteration of the smaller measures, namely, of those

> used for the sale of Beer, and especially if that alteration had been to decrease their size, would very likely have created a great degree of prejudice in the lower orders against the introduction of the new measures. By the Standard in this Bill, no sensible alteration will be introduced in the retail Beer measures, which are also the Measures employed for the retail of Flour, and other articles which are sold in small quantities by measure. (Great Britain Parliament. Sessional Papers 1824: 442).

The slight alteration was to judge the Standard by weight instead of by cubic capacity so that the new gallon weighed 10 pounds instead of the rather awkward 10 pounds, 2.75 ounces of the beer gallon. Passage of the act by no means standardized the sizes of bottles used in the apothecary, wine, or beer trades (Great Britain. Parliament. Sessional Papers 1842: 305-6, 352-53, 358, 362).

In addition to the official quarts another was widely recognized not only in Britain but also in Europe (Moody 1960; Bontemps 1868: 497). This "quart" held about 757 mL and is still widely used today in the wine and liquor trades — generally as 750 mL. Sometimes called the reputed quart, Moody (1960: 64) has traced the term as far back as 1824 but it was in use before that time. The term probably originated in official phrases of the type used in a 1695 act:

> For all quart bottles of green glasse flask glasse or any other kind of glasse whatsoever and for all glass-Bottle works [products] whatsoever commonly called or reputed quarts...(6 & 7 William and Mary c. 18 quoted in Buckley 1914: 24).

Both the term and the concept had received official recognition in Britain by the 1790s. A 1793 act concerning customs and excise duties to be paid by naval officers on wine for their own use stated that "every five reputed Quart Bottles shall be deemed and taken to be equal to one Gallon" (Great Britain. *Laws and Statutes.* 33 Geo. 3, cap. 48, s.4). There is no doubt that the gallon was the Queen Anne wine gallon and that the bottles in question held ideally 757.7 mL, the "reputed quart." Other acts from the late 18th and early 19th centuries also used the phrase "reputed quart or pint bottles." For example, in 1811 the excise laws concerning the production of dark green glass bottles stated that

> ...no Maker or Makers of Glass shall make of common Bottle Metal, any Bottle or Bottles smaller or of less Size or Content than what is commonly deemed and reputed an Half Pint Bottle (Great Britain. *Laws and Statutes.* 51 Geo. 3, cap. 69, s. 37).

Ideally the half-pint bottle should have contained about eight ounces wine measure (236.6 mL). In 1812 Benjamin Harrison of Sir Guys Hospital in London requested that the Hartly Pans Bottle Glassworks be allowed to continue manufacturing in dark green bottle glass a type of bottle in common use but whose actual capacity was closer to six ounces (about 190 mL), i.e. a reputed half-pint. The excise office ruled that they were willing to accept the reputed half-pint being made by bottle manufacturers

(Great Britain. P.R.O. *Customs 48:* Vol. 52, 334-35).

Even after the introduction of the imperial system the reputed quart continued to be made and widely used, but it now became six bottles to the gallon (imperial) rather than five. Wine merchants Barret and Clay seem to have regarded the reputed quart as the most desirable for the home trade and consigned bottles smaller than this to the export trade. The Inspector of Weights and Measures at Bristol complained bitterly that imperial quart bottles were seldom, if ever, made (Great Britain. Parliament. Sessional Papers 1842: 353, 365). The commissioners studying the weights and measures system concluded that

> the very extensive use of the wine-bottle, and its ordinary recognition as a measure of 1/6-gallon, are sufficient reasons for recommending that it be added [to the Measures of Capacity] (Great Britain. Parliament. Sessional Papers 1842: 276, 281).

It is not clear whether the other systems of measure were also subject to a reputed quart. There is some evidence to suggest that it might also have applied to the beer gallon, or at least was used in the beer trade. In 1824 there is a reference to selling Strong Beer in quantities not less than two dozen reputed quart bottles at one time (Great Britain. *Laws and Statutes.* 5 Geo. 4, cap. 54, s. 6). In a letter to the Chancellor of the Exchequer in 1831, Mr. Matthew Harrison stated that

> Bottle glass duty is taken upon the manufactured article in weight, principally consisting of reputed quart bottles and reputed pint bottles in wine and beer; all other articles in bottle glass being of minor importance (Great Britain...1835: 68).

One fifth of a beer gallon would be 924.2 mL., not a size that occurred often in the sample studied.

The glass-forming technology of the time made it difficult to make bottles of consistent and intentional capacities. Bottle blowers, using dip moulds and three-piece moulds, had some control over the external dimensions of an individual bottle but could not control the internal dimensions. In 1841 Barret and Clay, wine merchants in London, described the manufacture of bottles in moulds:

> It is the object of the glass-blower to make his bottles all of one size if possible, and the mould for all reputed quart bottles is, or ought to be, one size in every manufactory, so that the difference in the size of the bottles is not intentional. There are many causes for the difference; the blower may take more or less of the fused metal on the end of the tube than is necessary for his bottle, and he may blow it in the mould either too much or too little, which would make the glass thinner or thicker. The mould comes up to the shoulder of the bottle only, and sometimes the metal adheres to the sides; consequently, when the workman draws out the metal to make the shoulder, he sometimes elongates the straight part of the bottle, and of course that will make it both higher and thinner. Then (as we mentioned before) the shoulder may be more or less

> bowed; and besides these errors, the *push* as it is called, at the bottom of the bottle, may be pushed in too much or not enough...this would alter the contents of the bottle (Great Britain. Parliament. Sessional Papers 1842: 353).

Barret and Clay also commented that the "patent bottles" [Ricketts' bottles], although neater in appearance, varied nearly as much in size as those blown in the dip moulds. In the same report Apsley Pellatt stated that he knew of no method of manufacture that would give an accurately sized bottle. Bontemps (1868: 497-98) noted that bottles made one after another could vary from each other by 10 to 30 to 60 mL. He felt that one should be more concerned that a bottle contained genuine Château Lafite than whether or not it contained 650 or 750 mL.

At the beginning of this study I assumed that a range of "quart" capacities would cluster around the reputed quart of 757 mL. However, a preliminary series of capacity measures taken soon after the study began made it clear that this was not the case. Bottles identifiable visually as "quarts" ranged in capacity from 675 mL to 1250 mL.

Two capacity measures can be used on bottles. *Brimful capacity* (Fig. 87), taken to the top of the bottle, represents the maximum capacity. Although it can be duplicated by other researchers, making it statistically reliable, it is not a realistic capacity as no bottle is sold filled to the brim. *Filling height capacity* (Fig. 88) allows room for the cork and a small air space under it and represents the estimated functional capacity of the bottle. Because it is subject to individual interpretation, however, it cannot be duplicated exactly by other researchers. Although one can never be sure to what point the bottles were filled in their period of use, filling height is closer to the "real" capacity than is brimful height. I decided, therefore, to use filling height capacity for this study. As the bulk of the volume is contained in the body and shoulder — the volume predictor formula uses only base diameter and body/shoulder height — the difference between the two capacities is not so great that the conclusions reached in this study would be substantially altered by using brimful capacity. To arrive at brimful capacity for bottles used in this study add 15 to 20 mL to the filling capacity.

Five size groups were identified using the bottles measured for capacity and those whose capacity was estimated using the volume predictor formula: $\log_e (\text{vol.}) = -9.3011 + 1.97 \log_e (\text{base diam.}) + 1.3729 \log_e$ (bottle height -neck height). The sizes of the measured bottles corresponded to gallons (3229-3321 mL), half-gallons (1310-1740 mL and 2000-2360 mL), quarts (675-1250 mL), pints (325-553 mL), and half-pints (192-250 mL). There were two gallons, three half-pints, 15 half-gallons, 17 pints, and almost 300 quarts in the sample. The capacities do not cluster around any of the official sizes. It also seems that the quarts were used as standards instead of the gallons because the capacities of the half-pints, pints, half-gallons, and gallons, when multiplied or divided by two or four, reflected those of the quarts. Because of the closeness of the various official quarts and chopins, and because the bottlemakers do not appear to have tried to make quarts of official sizes, it is difficult to know which systems of measure are represented by the "quart" capacities. Most were probably representative of the English wine, beer, or imperial measurement system. The majority of the bottles I examined were made in England for English markets or came from English colonies overseas. Also, I have been able to link different body styles with these capacity systems (see Bodies). Bottles made for the Irish or Scottish markets may have identifiable differences based on their systems of capacity measurements but one has to study bottles with known Scottish or Irish attributions.

The wide variety in quart capacities did not pass unnoticed by interested lay persons, merchants, or government officials. They recognized the myriad opportunities for fraud.

> I come now to a most important Part of your Economy, the bottling of a Hogshead of Wine,...Let your Corks be of the longest Kind you can get; which will save some Wine in the Neck of every Bottle: As to your Bottles, chuse the smallest you can find, which will increase the Number of Dozens, and please your Master; for a Bottle of Wine is always a Bottle of Wine, whether it hold more or less; and if your Master hath his proper Number of Dozens, he cannot complain (Swift [1749?]: 27).

Wine merchants in England devised a system that compensated for the varying bottle capacities. This system was based on a dozen quart bottles that, ideally, should have held three gallons of wine. As the bottles generally did not hold a full quart the three gallons were taken as a substitute and the number of bottles per dozen was adjusted accordingly so that the "dozen" could be anywhere from 12 to 18 bottles.

> ...in 1739 one John Sherigley complained that wine was sold in bottles named quart bottles, and that merchants had sent for bottles beyond the seas, fifteen of which contain only twelve quarts (Westropp 1978: 143).
>
> Fine Old Red Port at 1s. 6d. per Quart, 6s. per Gallon, 18s. per Dozen 13 bottles *(The Gazetteer and London Daily Advertiser* 16 Nov. 1762).
>
> May 12th, 1797
>
> Sir
>
> The Bottles blown in the narrow Mould are just as I could wish Send me 1,200 doz of Moulds by each Sloop all blown in the narrow mould as near 15^{ns} as possible incline to 16 rather than 14^{ns}.... (N.C.R.O. 2DE 11/11/102).
>
> Legal Measure — Thomas Wiglesworth is selling Cape Madeira (an excellent family wine) at 25s per dozen, namely 3 gallons legal measure, in 15 regular size bottles...*(The Times* [London], 5 Dec. 1821).

In a letter to the excise examiners in London the excise collector at Bristol commented on some castor oil bottles shipped to Ireland by Henry Ricketts and Company:

> The Treasury Order of 28 July 1823 allows a drawback of 15^{d} p dozen on reputed quart Bottles exported to Ireland, but these Bottles which are made very thin & light for the purpose of containing oil only & not for general purposes, cannot be deemed reputed quart Bottles, and as it takes 19 to fill three Gallons, the average reputed quarts being about 16, in my opinion the Drawback should be 8^{s}/2^{d} p Cwt. agreeably to what has been charged upon them (Great Britain. P.R.O. *Customs 48* T. 5890/28).

In the weights and measures enquiry conducted in the early 1840s several witnesses attested to the fact that, in spite of the passage of the imperial system in 1824, the range of sizes still in use continued to be large. The Inspector of Weights and Measures at Bristol noted that the wine trade used a scale of bottles from No. 12 down to 18. His capacity evidence is confusing as he seems to switch back and forth between the imperial system and the Queen Anne wine gallon but he states that "A dozen of the No. 15's contain 2 gallons imperial [757 mL per bottle"] (Great Britain. Parliament. Sessional Papers 1842: 358). Apsley Pellatt commented that "from the common quart bottles blown as one size are picked sizes, as various in content as 13 up to 16 to the 12 imperial quarts, but such sizes can only be selected when cold by measuring every bottle with water" (Great Britain. Parliament. Sessional Papers 1842: 364). In the same report Barret and Clay reported that respectable wine merchants used three bottle sizes: small 4's which held 27.5 ounces (781.36 mL), 5's which held 27 ounces (767.15 mL) when the quantity to make room for the cork was thrown off, and 5's which held 26.5 ounces (752.95 mL) when filled brimful. They also noted that a larger size for beer held 29.5 ounces (838.9 mL). Other than this reference and those to reputed quart wine and beer bottles no documentary evidence was found to suggest that the beer trade also used a fluid dozen. Evidence from the bottles themselves does suggest that the dozen bottles of beer may have contained more than 12 bottles because the beer bottles varied almost as much in capacity as the wine bottles.

No documentation was found for the use of systems such as this in North America. Most newspaper advertisements simply use "dozen" without commenting on the number of bottles involved.

Once sized, the bottles were used in different markets. Bontemps (1868: 497) admitted that some unscrupulous merchants, when selling wine by the dozen, tended to use bottles of less capacity when dealing with foreigners or with country folk. William Powell, a Bristol manufacturer of glass and stoneware, noted that the bottles used in Bristol "and in our English connexions are about one in *fourteen* larger than those used in London....In Ireland we sell a smaller bottle, about the size of the London trade" (Mountford 1975: 36). Barret and Clay also observed that

> The merchant finds a great number of bottles amongst those he receives below the standard of 6 to a gallon, and these are used for exportation from the docks, by those who export largely, to compensate for the low price to be obtained. It would be desirable for the home trade if this bottle could be done away with; but it would be a serious loss to the manufacturer (Great Britain. Parliament. Sessional Papers 1842: 353).

It has not been possible to determine whether there is a difference in capacity between the wine-style quarts from the sealed and dated sample and the North American archaeological material. Too few examples from either group have been measured for capacity to provide an adequate base for comparison. The estimated capacity is not accurate enough to be used for this purpose. There is a suggestion, however, that the larger beer-style quarts are less common in North American archaeological contexts whereas the undersized beer-style quarts are very common (see Bodies). Because of the difference in base diameters between the two styles, one does not have to measure them for capacity to tell them apart.

Table 24. Official bottle sizes (in millilitres)

	Gallon	Pottle	Quart	Pint	1/2 Pint	Chopin	Mutchkin
Queen Anne wine gallon 231 cu in.[a]	3785.4	1892.7	946.3	473.2	236.6		
Ale/beer gallon 282 cu in.	4621.1	2310.6	1155.3	577.6	288.8		
Scotch pint							
103.404 cu in.	13 555.8		3388.96	1694.481		847.24	211.8
105 cu in.	13 765.1		3441.3	1720.6		860.3	215.1
Scotch ale pint 111.6 cu in.	14 630.3		3657.6	1828.8		914.4	228.6
Irish gallon							
272.25 cu in.	4461.4	2230.7	1115.3	557.7	278.8		
217.6 cu in.	3565.8	1782.9	891.5	445.7	222.9		
Imperial gallon 277.42 cu in.	4546.1	2273.0	1136.5	568.3	284.1		

[a] 1 cu in. = 16.387 cc/mL

MEASUREMENTS

Part of the original purpose of this study was to develop a way to use actual measurements to assist in dating individual bottles or fragments. As an experiment I wanted to compare the results from this technique with the dates of bottles from archaeological contexts with a known date of deposition. All the measurement data were turned over to the Computing and Applied Statistics Directorate, Environment Canada, Ottawa. The original analysis carried out by Chitra Vithayasai resulted in the development of four formulas, three related to dating and one related to capacity (Appendix C). Phillip Cohen and Richard Aylesworth completed subsequent work on the project.

Capacity Estimates

$\log_e$ (vol.) = -9.3011 + 1.97 $\log_e$ (base diam.) + 1.3729 $\log_e$ (bottle height - neck height)

Bottle height minus neck height gives the height of the bottle to the base of the neck. This formula can be used for bottles ranging in capacity from a half-pint to a gallon. At the approximate 95 per cent confidence interval the error will be slightly less than ±12 per cent of the true value.

Dating Estimates

Using the measured attributes, regression formulas were developed to estimate the manufacturing dates of complete bottles, neck fragments, and base/body fragments. These formulas apply to "quart" bottles only.

Whole Bottle Formula

date = 1779.5 + 1.1183 (neck diam. 2) - 1.2207 (neck ht.) - 0.65191 (body ht.) -1.1309 (base diam.) + 0.79558 (rest. pt. diam.) -0.41244 (pont. mark diam.) + 0.86582 (bottle ht.) + 2.7918 (lip) -6.6852 (lip indicator)

When "lip indicator" is = 1, use lip height for "lip." When "lip indicator" is = 2, use lip to string rim height for "lip." At the approximate 95 per cent confidence interval, the estimated date is within ±15 years of the date of manufacture of the bottle. For example, a bottle with an estimated date of 1790 has about a 95 per cent chance of having been made between 1774.6 and 1805.4.

Neck Fragment Formula

date = 1740.0 -1.1332 (bore diam.) + 1.7357 (finish ht.) + 2.0156 (neck diam. 1) + 2.1880 (lip) -20.296 (lip indicator)

When "lip indicator" is = 1, use lip height for "lip." When "lip indicator" is = 2, use lip to string rim height for "lip." At the approximate 95 per cent confidence interval, the estimated date for a neck fragment is within ±22.4 years of the date of manufacture for the bottle. A neck fragment with an estimated date of 1790 has about a 95 per cent chance of having been manufactured between 1767.6 and 1812.4.

Body/Base Fragment Formula

date = 1925.1 + 1.3838 (body diam. 3) - 3.2425 (base diam.) + 1.4577 (rest. pt. diam.) -0.47098 (indent ht.) - 1.0197 (pont. mark diam.)

At the approximate 95 per cent confidence interval the estimated date for a base fragment is within ± 33 years of the date of manufacture of the bottle. A body/base fragment with an estimated date of manufacture of 1790 has about a 95 per cent chance of having been manufactured between 1757 and 1823.

For all three formulas the statistician used a stepwise forward and backward procedure to pick the set of measurements whose inclusion in the formula resulted in a substantial reduction of the standard error. In addition, for the body/base and neck formulas we chose measurements that could be taken on the largest number of archaeological fragments. For example, to use the neck formula one only needs the finish and enough of the neck to take neck diameter 1 — about 5-6 per cent of the bottle. Additional measurements would reduce the number of fragments that could be dated by using the formulas but not substantially reduce the standard error. The contribution made by each of the measurements to the formulas can be established by subtracting the minimum coefficient value from the maximum coefficient value (Appendix C, Figs. 3-5). The contribution by an individual measurement varies from one formula to another. For example, for the whole bottle formula, the pontil mark diameter affects the age estimate by 16.1 years (33.4 - 17.3 = 16.1) and the bottle height by 90.9 years (258.0 - 167.1 = 90.9). In the base formula the pontil mark diameter affects the age estimate by 39.8 years.

Obviously complete bottles will have more satisfactory estimated dates but the neck fragment formula results can also be considered acceptable. The date ranges from the body/base formula, however, are so broad that the results are virtually meaningless. The base formula is less successful because the body, base, and resting point diameters were repeated in different time periods, depending on whether the bottle in question had a wine-style, beer-style, undersized beer-style, or imperial wine-style body (see Bodies). The whole bottle and neck formulas are more successful because they are less dependent on the changing body styles. The finish area in particular seems to have changed independently from the rest of the bottle.

An alternative statistical technique, discriminant analysis, was also considered for estimating manufacturing dates (Cohen and Aylesworth 1984: pers. com.). In this approach seven simultaneous linear regression equations (instead of one) were used to classify complete bottles, neck fragments, or body/base fragments into one of seven decades (1740-1810). Thus, for example, if one substituted the appropriate measurement data into the seven linear discriminant equations the discriminant analysis computer package might estimate that a particular bottle was manufactured in the 1780-90 decade. As a rough guide to test the relative accuracy of the two statistical methods a comparison was made of the percentage of the bottles or fragments that were correctly classified into their appropriate decade of manufacture. Table 25 shows that the use of the discriminant approach does give a more refined estimate of the date of manufacture. However, to do the discriminant analysis one has to use a computer whereas the regression estimates of the date of manufacture can be obtained by hand.

Table 25. Percentage of bottles correctly classified into the appropriate decade (1740-1810)

	Regression approach	Discriminant approach
Complete bottles	49	80
Neck fragments	42	58
Body/base fragments	34	53

It must be stressed that either technique can only be regarded as an additional tool for establishing an estimated manufacturing date of an individual bottle or fragments. The dates derived from the formulas should be verified as reasonable by looking at the finish and body styles and the manufacturing techniques used. In the same way, the date range for a given bottle may be narrowed. For example, a bottle made in a three-piece mould with a finish shaped by a finishing tool and having an estimated date of 1820 is unlikely to have been made before 1820. The most likely date of manufacture, therefore, would be between 1820 and 1835.

Estimating the Average Age of Bottles from an Archaeological Assemblage

As an experiment we used the results from the regression formulas to arrive at mean manufacturing dates for bottles from archaeological assemblages with known dates of deposition. Because the formulas give an estimated manufacturing date and the assemblage date is a discard date, this experiment does not test the validity of the formula results.

I selected three assemblages (dated 1760, 1813-15, 1835-ca. 1853) that had relatively large collections of whole and fragmentary bottles. For each assemblage I calculated the mean manufacturing date of whole bottles, neck and base fragments (Table 26) and compared the results. I checked the results against the date ranges of the finish styles and of the manufacturing techniques. Whole bottles, not too surprisingly, tended to give the best results, followed by neck fragments. The results from the base fragments were so erratic that it is doubtful whether they should be used to estimate the average manufacturing age of an assemblage. The standard error for an assemblage is considerably reduced from that for individual bottles or fragments.

The formula for estimating the mean manufacturing date of bottles from archaeological assemblages is (Cohen 1983: pers. com.):

Let

n_w = number of whole bottle age estimates
n_n = number of neck fragment age estimates
n_b = number of body fragment age estimates
n = $n_w + n_n + n_b$
S_w = Standard error of whole body estimate
= 7.7 years
S_n = Standard error of neck fragment estimate
= 11.2 years
S_b = Standard error of body fragment estimate
= 16.5 years
Y_w = Average of n_w whole body estimates

$\underline{Y}_n$ = Average of $\underline{n}_n$ neck fragment estimates
$\underline{Y}_b$ = Average of $\underline{n}_b$ body fragment estimates
$\underline{Y}$ = Average of $\underline{n}$ body fragment estimates
$\underline{S}$ = Standard error of the estimate of $\underline{Y}$

then

$$\underline{Y} = \frac{1}{\dfrac{\underline{n}_w}{\underline{S}_w^2} + \dfrac{\underline{n}_n}{\underline{S}_n^2} + \dfrac{\underline{n}_b}{\underline{S}_b^2}} \left[\frac{\underline{Y}_w \underline{n}_w}{S_w^2} + \frac{\underline{Y}_n \underline{n}_n}{S_w^2} + \frac{\underline{Y}_b \underline{n}_b}{S_w^2} \right]$$

The formula for the approximation for the standard error is (Cohen 1983: pers. com.):

$$\underline{S} = 1/(\underline{n}_w/\underline{S}_w^2 + \underline{n}_n/\underline{S}_n^2 + \underline{n}_b/\underline{S}_b^2)^{1/2}$$

To calculate the approximate 95% confidence interval $\underline{S}$ is multiplied by 2. It is noteworthy that if only one bottle formula is used, e.g. whole bottles ($\underline{n}_n = \underline{n}_b = 0$), the standard error for that formula is multiplied by 2 and divided by the square root of the number of examples used. For example, in Case 1 where five bottles were used the whole bottle calculation was as follows:

$$7.7 \times \frac{2}{\sqrt{5}} = \pm 6.9.$$

At the approximate 95% confidence interval the mean date of 1757.7 is within ±6.9 years of the date of manufacture for this group of complete bottles.

Case 1

The assemblage came from the *Machault*, a French ship scuttled in 1760 (Sullivan 1979). The bottles are a relatively homogeneous group and the mean date of manufacture is compatible with finish and body styles of the period. In this example the mean manufacturing date for the whole sample is very close to the deposition date. When the bases are excluded, however, the mean manufacturing date for the whole bottles and necks is probably closer to reality.

Case 2

A sealed deposit of disturbed soil between the walls of the mess house and the guard house at Fort Lennox, Quebec, is dated by the presence of creamware plates and stemware marked with the crest of the 13th Regiment of Foot. The Regiment served in Canada between 1813 and 1815 and was at Fort Lennox on several occasions (Ashworth 1967: 45-48). Marked regimental messware such as this would not have been left behind for other regiments to use (Jones and Smith 1985: 114).

The bottles have a mixture of Group 2 and Group 3 finishes and on visual inspection appeared to date to the late 18th and early 19th century (Jones 1967). The mean manufacturing dates for the whole bottles and neck fragments were compatible with those dates. The base dates were, however, about 20 years earlier and pulled the mean manufacturing date for the whole assemblage back by about four years.

Case 3

These bottles came from a privy in use between 1835 and the early 1850s (Beaudet 1981: 86). The bottles are a mixture - some were blown in dip moulds, some in three-piece moulds, all have abrupt heels, and some of the finishes were formed by a finishing tool. Several examples did not have pontil marks and could not be used. On visual inspection the collection dated after the 1820s and into the early 1850s.

The mean manufacturing date for the whole bottles was early but within the realm of possibility. The dates from both the neck/finishes and bases were, however, so much earlier that we decided to re-examine the formulas. For the regression formulas the results at either end of the time frame will tend to be less accurate than those toward the centre (Appendix C). In an attempt to improve the results from the formulas Cohen and Aylesworth (1984: pers. com.) tried dividing the sample into three time periods (1737-60, 1760-1820, 1820-50) but there was no appreciable decrease in estimation errors at either end of the date range for the bottles that were used to make the regression. The formulas were left as they were originally. A likely explanation for the unsatisfactory results attained for the Case 3 bottles is that the original sample contained only eight quart bottles dated between 1830 and 1850 and may not be representative of the period.

The Measurements

Because of the tools and manufacturing processes used in the manufacture of the dark green glass English "wine" bottle, irregularities were commonplace, particularly in examples made before ca. 1820. Standardized methods of dealing with these irregularities were not established at the beginning of this study as they should have been, partly because at first it was not perceived as a problem. Nevertheless, a method of taking the measurements evolved over the period of the study. For some measurements, particularly in the finish and base area, I took a minimum and maximum value and the mid-point was used in the statistical analysis. Researcher bias, without extremely rigid and time-consuming controls (see Baker 1977), is unavoidable considering the three-dimensional aspect of the containers in addition to their irregularities. However, the results from the formulas should not be substantially different from one researcher to another if they take the same measurements I did.

Tools

1) Vernier calipers with inner and outer diameter capabilities and depth measure, a rod that extends from the end of the calipers.
2) Metric spreading calipers.
3) Metal metric ruler in which the markings begin at the edge of the ruler, not 2-3 mm in from the edge.
4) Dividers.
5) 500 mL/cc cylinder.
6) Standardized recording sheets.

Measurement Definitions

All measurements were taken in metric units. When taking measurements, I held the calipers or ruler in a straight line with the feature being measured or at right angles or parallel to the vertical or horizontal plane of the bottles (Figs. 82, 83).

Bore diameter (Fig. 72). Bore diameter was taken at the beginning of the bore using the inner diameter of the Vernier calipers

Lip to string rim height (Fig. 73). The measurement applies only to flat-topped lips or to lips that have a slightly V-shaped profile but are essentially unthickened and are the same size as the glass in the neck (Group 1 finishes). The measurement was taken from the top of the string rim to the outer edge of the lip using the inner or outer diameter of the Vernier calipers.

Lip height (Fig. 74). The measurement applies to lips that are thickened or widened compared with the width of the glass in the neck (Groups 2, 3 finishes). The measurement was taken from the lower edge of the lip to the upper edge of the lip using the outer diameter of the Vernier calipers and keeping the measuring surfaces of the calipers in a straight line with the upper and lower lip edges.

Lip indicator. Lip to string rim height and lip height are mutually exclusive measurements. In the formulas use 1 when lip height is present; use 2 when lip to string rim is present.

String rim height (Fig. 75). The height of the string rim was taken from the top of the string rim to the bottom, using the inner or outer diameter of the Vernier calipers and keeping the measuring surfaces of the calipers in a straight line with the upper and lower string rim edges.

Finish height (Fig. 76). The height of the finish was taken from the top of the lip to the bottom of the string rim, using the outer diameter of the Vernier calipers.

Neck diameter 1 (Fig. 77). Neck diameter 1 was taken just under the string rim using the outer diameter of the Vernier calipers.

Neck diameter 2 (Fig. 77). Neck diameter 2 was taken at mid-point between the bottom of the string rim and base of the neck using the outer diameter of the Vernier calipers.

Neck diameter 3 (Fig. 77). Neck diameter 3 was taken at the base of the neck using the outer diameter of the Vernier calipers. In examples where the neck curved gently into the shoulder I used the mid-point of this curve as the base of the neck. In examples where the neck curved abruptly into the shoulder, the base was easily distinguished.

These three diameters were generally taken in a straight line down the neck.

Neck height (Fig. 78). The neck height was taken from the top of the lip to the base of the neck. I placed the ruler at the base of the neck, then placed the depth measure of the Vernier calipers across the top of the lip to intersect at right angles with the ruler. For neck fragments I found the inner diameter of the Vernier calipers more convenient to use. In examples where the neck curved gently into the shoulder I used the mid-point of this curve as the base of the neck. In examples where the neck curved abruptly into the shoulder, the base was easily distinguished.

Body-shoulder height (Fig. 80). I subtracted the neck height from the total body height.

Body diameter 1 (Fig. 79). Body diameter 1 was taken at the body-shoulder junction using the spreading calipers.

Body diameter 2 (Fig. 79). Body diameter 2 was taken at the mid-point between body diameter 1 and 3 using the spreading calipers.

Body diameter 3 (Fig. 79). Body diameter 3 was taken at the lowest point on the body in which the slope of the body is undisturbed. For examples with basal sag, this diameter was taken just before the heel begins to swell. For examples with rounded or abrupt heels this diameter is essentially the same as the base diameter. I used the spreading calipers.

The above three diameters were generally taken in a straight line down the body.

Body height (Fig. 81). The height of the body was taken from the table to the body-shoulder junction, the point at which the body begins to curve inward to form the shoulder. The ruler was placed perpendicular to the table and the line of the body-shoulder junction was extended outward by eye to intersect at right angles to the ruler.

Base diameter (Fig. 83). The diameter was taken on the outer edge of the heel using the outer diameter of the Vernier calipers. When basal sag was present, this diameter was of the basal sag. For bases with abrupt or rounded heels this was the outer edge of the base and was generally the same as body diameter 3.

Resting point diameter (Fig. 84). This is the diameter of the point of the bottle that rests on a surface when the bottle is standing upright. I used a ruler or the outer diameter of the Vernier calipers. When the resting point was worn flat, I took the diameter from mid-point to mid-point of the worn area.

Indent height (Fig. 85). The indent height was taken from an imaginary plane across the resting point to the maximum depth (height) of the pushup using the depth measure of the Vernier calipers.

Pontil mark diameter (Fig. 86). The outer diameter of the pontil mark was measured with dividers which were then placed against a ruler.

Bottle height (Fig. 82). The total bottle height was taken from a flat surface to the top of the finish, irrespective of the type of lip present. The ruler is placed perpendicular to a flat surface, parallel to the bottle. The depth measure of the Vernier calipers is placed across the top of the finish to meet at right angles to the ruler.

Volume (Figs. 87-88). For this study I used estimated filling height. Filling height allows room for the cork and for "head space" below the cork. The bottles were filled with water to within 40-50 mm from the top of the bottle and the water was then poured into a 500-mL graduated cylinder as many times as was necessary.

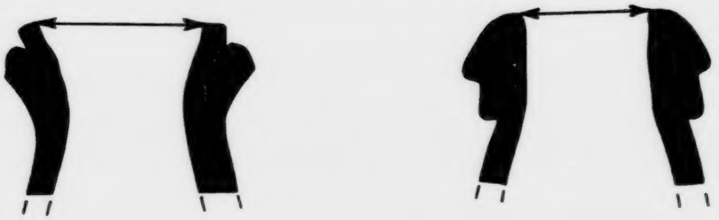

Figure 72. Bore diameter.

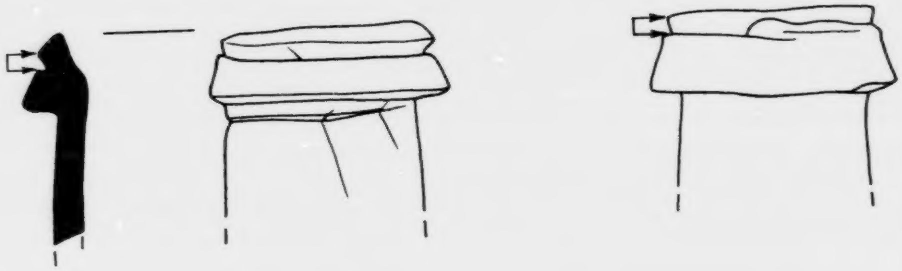

Figure 73. Lip to string rim height.

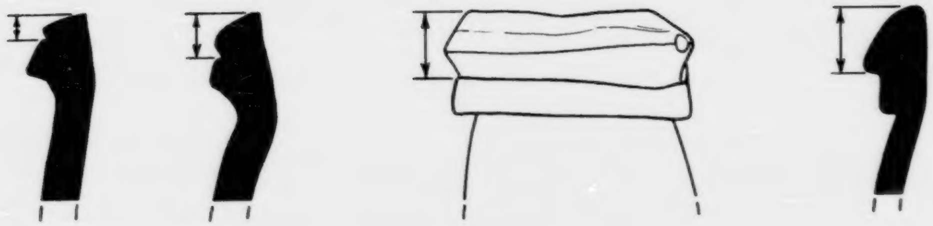

Figure 74. Lip height.

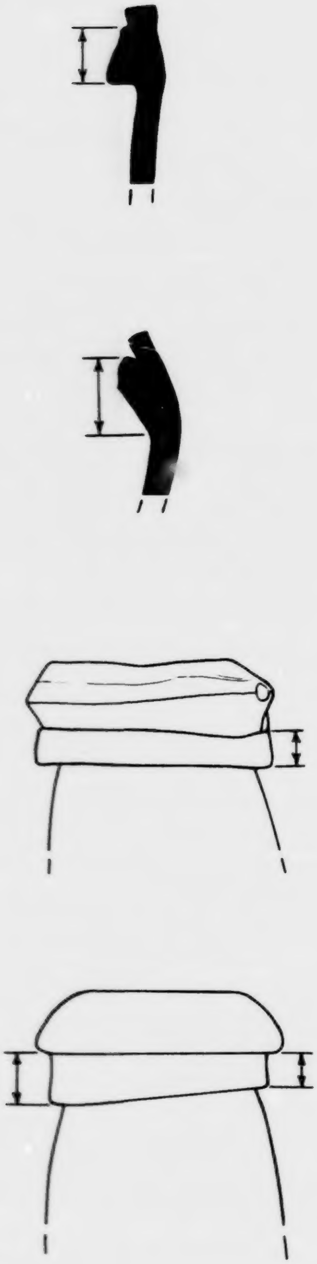

Figure 75. String rim height.

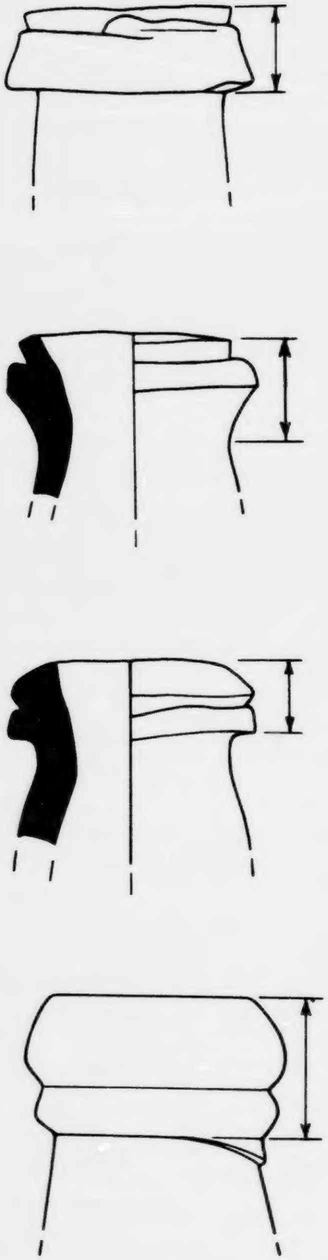

Figure 76. Finish height.

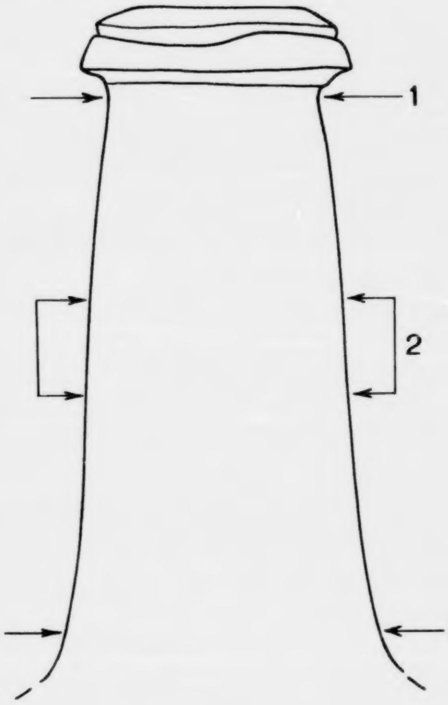

Figure 77. Neck diameters.

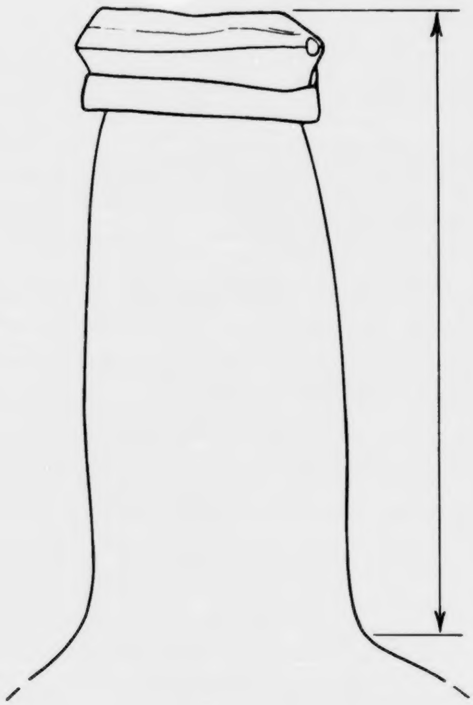

Figure 78. Neck height.

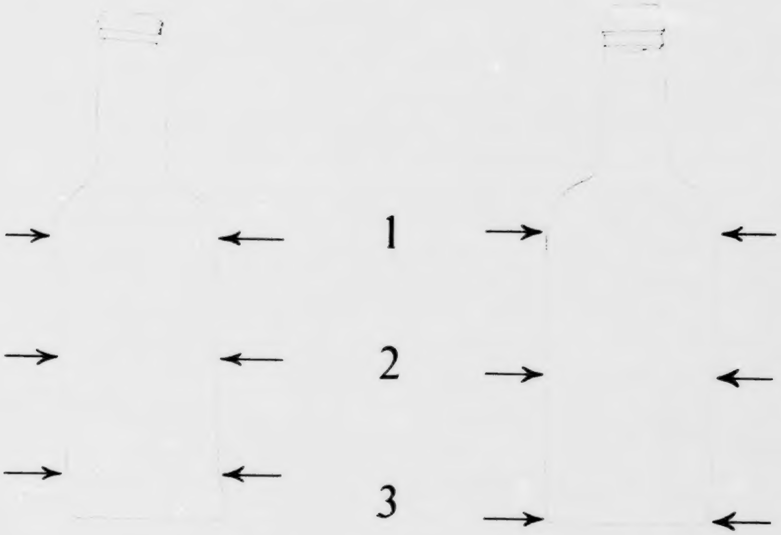

Figure 79. Body diameters.

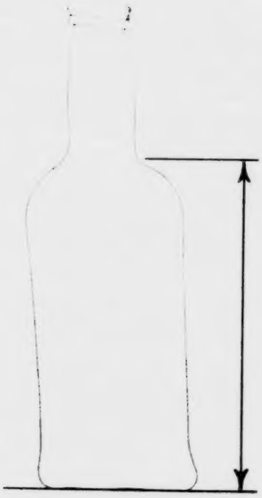

Figure 80. Body/shoulder height.

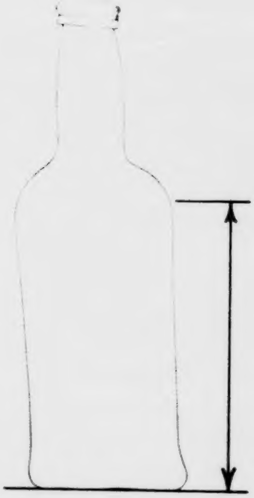

Figure 81. Body height.

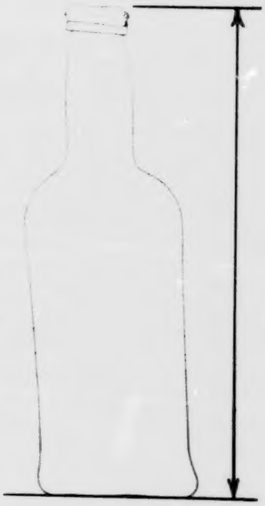

Figure 82. Bottle height.

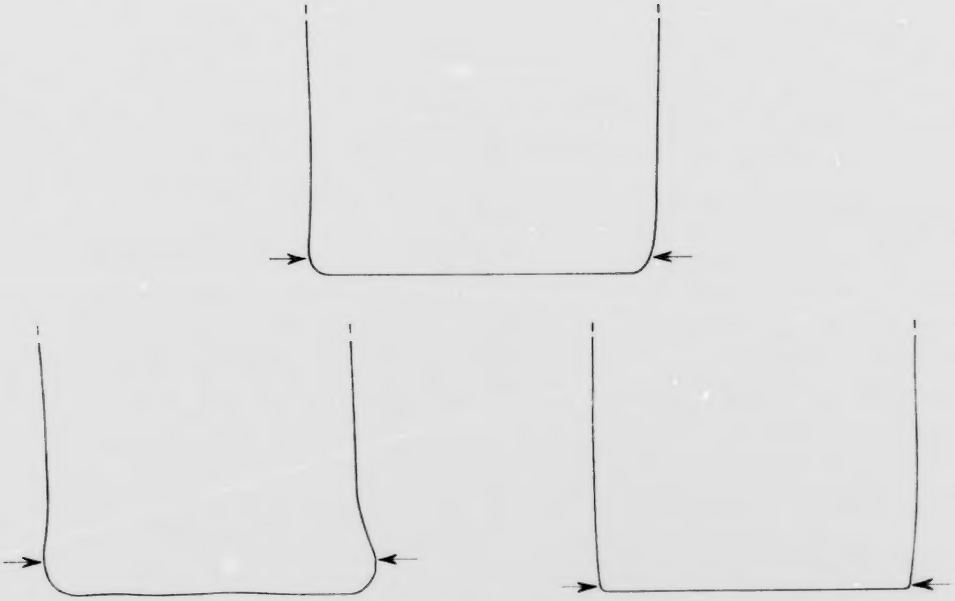

Figure 83. Base diameter.

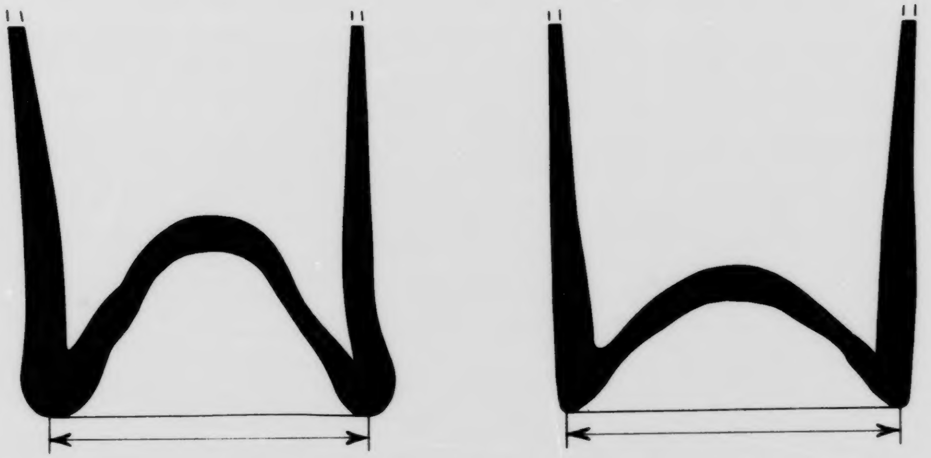

Figure 84. Resting point diameter.

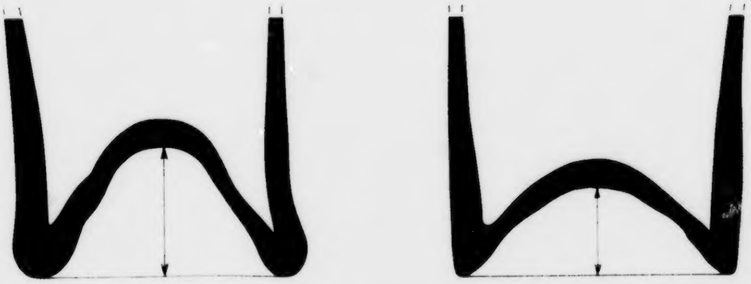

Figure 85. Indent height.

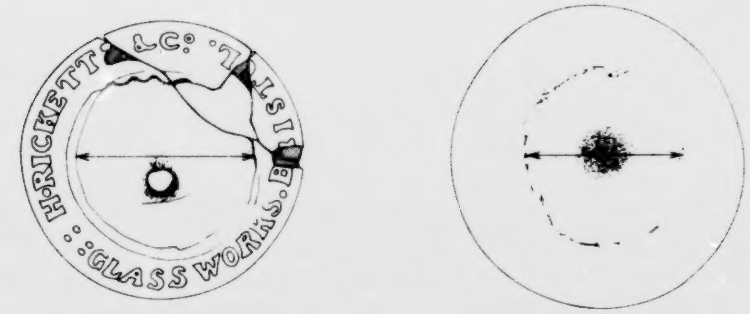
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Figure 86. Pontil mark diameter.

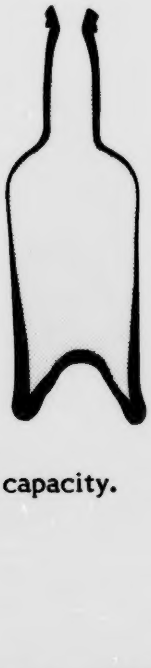

Figure 87. Filling capacity.

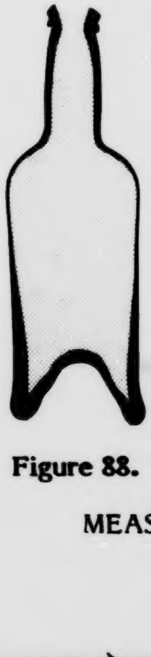

Figure 88. Brimful capacity.

Table 26. Comparison of mean manufacturing dates for three archaeological assemblages, using regression formulas

	Case 1			Case 2			Case 3		
	No. of examples	Estimated mean date of manufacture	At approx. 95% confidence interval	No. of examples	Estimated mean date of manufacture	At approx. 95% confidence interval	No. of examples	Estimated mean date of manufacture	At approx. 95% confidence interval
Whole bottles	5	1753.7	±6.9	7	1802.6	±5.8	7	1831.5	±5.8
Neck fragments	23	1759.4	±4.7	23	1801.6	±4.7	2	1814.2	±15.8
Base fragments	30	1768.7	±6.0	17	1780.1	±8.0	3	1804.3	±19.1
Total assemblage	58	1760.8	±3.3	47	1798.2	±3.3	12	1827.5	±5.3
Whole bottles & neck fragments	28	1757.6	±3.9	30	1802.0	±3.6	9	1829.4	±5.5
Whole bottles & base fragments	35	1762.2	±4.5	24	1794.8	±4.7	10	1829.2	±5.6
Neck fragments & base fragments	53	1762.9	±3.7	40	1796.1	±4.0	5	1810.2	±12.2
All necks (including whole bottles)	28	1759	±6.7	30	1801.6	±4.1	9	1813.6	±7.5
All bases (including whole bottles)	35	1767	±5.6	24	1782.5	±6.7	10	1807.5	±10.4

CONCLUSIONS

Since the beginning of this century researchers have recognized that the changes in "wine" bottles could be dated by comparing undated examples to dated ones. The methodology and expected results have varied from one researcher to another (Leeds 1914: Noël Hume 1961, 1970: 60; Carrillo 1972; Baker 1977; Robertson 1976; Dumbrell 1983). Implicit but generally not stated in the methodology is an assumption about the nature of the changes. Some think that they were gradual; others that they were sudden. It is clear from this study that the changes were sudden. A new style of finish or body was introduced, the new style and old style continued in production for several years, and then the old style disappeared. During the changeover periods some bottles were produced that could belong to either the old or the new - half a finish might be Group 2, half Group 3a for example. These bottles were not transitional forms as the old and new styles were being produced in the same time period. Either style was acceptable and these "hybrids" may have been an attempt to appeal to both those parts of the market wanting old-style and those wanting new-style bottles. Changover periods for techniques of manufacture seem to have been much longer than those for style.

If the changes in the "wine" bottles were sudden rather than continuous, then one has to ask why the regression technique was an appropriate one for estimating dates for bottles and fragments. First, the general trend of the changes for any one feature was always in the same direction. For example the bottles were getting progressively taller and narrower; the necks shorter and wider. Second, the changes in the various parts of the bottle did not all happen at the same time; sometimes the bodies changed before the finishes, sometimes the finishes changed first. The regression formulas smooth out these bumpy changes into a straight line. In fact, the size of the confidence interval for the whole bottle formula reflects the discontinuous nature of the changes. If the changes were gradual rather than abrupt, the confidence interval for the whole bottles should have been less than ± 15 years.

What caused the changes in the "wine" bottles' appearance? At least some of the changes can be attributed to technological advances. The dip mould, the three-piece mould, the finish-forming tool, and base-forming moulds all accelerated production and helped decrease irregularities in the bottles. On the other hand, development of the lip does not seem to have had any practical application and apparently was caused by a desire to change its appearance. Indeed, as each bottle required less than a minute to make, the additional seconds required to tool the lip would have reduced the number of bottles made in a day. Whether the impetus for this change originated with the bottlemakers or with their customers has been impossible to assess. The lengthening of the bottle may have been related to the increased use of binning but many products sold in these bottles did not require maturing in the bottle. Again, change for the sake of change may have been the impetus for the increasing height.

There is much discussion in the field of material culture research about whether or not measurements are useful data to collect. For studies such as this one they have clearly contributed a great deal - not just to the development of the dating formulas but also to an understanding of what the different body proportions represented. Capacity in particular proved to be a key to explaining the seeming multitude of acceptable forms. The variations in size and body proportions exhibited in the quart "wine" bottles were not just random eccentricities but were deliberate choices, made for stylistic and commercial reasons. Through the use of measurements I have been able to show that the "wine" bottle was, in fact, a "wine" and a "beer" bottle.

One disappointment with this study was a failure to find written evidence for the introduction dates of the three-piece mould and the snap case. Both developments contributed to the improvement of manufacture of bottles and both make useful dating tools for all types of bottles. However, the technical literature of the time, such as technical dictionaries, encyclopedias, books by glassmakers, and government investigations into the glass industry, was silent on where and when both tools were introduced.

On the whole, however, the general aims of the study were achieved. Dates were established for finish styles and for the introduction of the finish-forming tool. It was established that measurements could be used to estimate the date of manufacture for individual bottles and fragments and to estimate mean date of manufacture for archaeological assemblages. Both the historical record and material from archaeological excavations have attested to the extensive use of the English "wine" bottle for a variety of commodities. Long before the introduction of the cylindrical form they were being used to ship products to all parts of the world, to store and mature wines, ciders, and beers, and to serve assorted beverages at the table.

APPENDIX A. BOTTLE MEASUREMENT DATA

AGE DISCRIMINATION OF ENGLISH WINE BOTTLES

BOTTLE NO	DATE ACTL	DATE PRED	BORE DIAM	LIP HT	LIP-STR RIM	STR RIM HT	FINISH HT	NECK DIAM 1	NECK DIAM 2	NECK DIAM 3	NECK HT	BODY DIAM 1	BODY DIAM 2	BODY DIAM 3	BODY HT	BASE DIAM	REST PT DIAM	INDENT HT	PONT MARK DIAM	BOTTLE HT	VOLUME ACTL	VOLUME PRED	WGHT FACT
1	1737	1746	22.0	0.0	3.8	9.0	13.0	28.0	33.0	46.0	74	131	131	130	86	132	105	44	62	197	1025	1017	.500
2	1737	1752	19.0	0.0	2.7	8.0	11.0	25.6	30.0	46.0	65	129	129	129	83	130	105	40	61	193	0	1042	.500
3	1738	1742	20.4	0.0	3.3	6.2	9.1	26.0	34.0	50.0	100	130	124	129	95	134	117	48	61	227	1070	1095	1.000
330	1738	1747	20.0	0.0	3.5	7.0	9.5	26.0	31.0	44.0	91	120	120	120	82	125	102	40	60	215	850	924	1.000
4	1739	1749	19.0	0.0	2.5	6.0	9.2	27.0	33.5	43.0	95	129	129	131	92	133	114	53	56	228	1030	1149	1.000
5	1742	0	21.0	0.0	4.0	7.3	11.0	22.0	26.0	40.0	78	99	98	101	65	104	86	37	58	172	360	440	1.000
6	1745	1744	20.5	0.0	3.5	5.0	8.5	28.0	35.5	53.4	100	124	123	123	102	125	106	43	61	230	1035	986	1.000
8	1745	1754	20.0	0.0	5.5	5.6	11.4	24.0	36.0	51.0	82	120	119	120	95	123	103	41	75	211	900	945	1.000
7	1746	1756	21.0	0.0	3.0	8.5	11.0	26.0	33.4	43.5	84	118	0	117	98	120	102	38	67	223	920	997	1.000
9	1747	0	19.0	0.0	3.0	4.0	0.0	27.0	38.0	62.0	102	129	126	127	90	129	109	44	0	231	0	1038	1.000
11	1750	1745	22.0	0.0	5.0	5.8	11.0	26.0	34.0	46.0	101	120	117	119	110	124	104	34	72	241	980	1074	1.000
12	1753	0	22.7	0.0	3.6	7.0	8.6	25.0	34.0	47.0	0	110	108	107	107	109	94	38	59	244	800	0	1.000
13	1753	1762	20.0	0.0	5.4	8.0	14.0	26.0	34.0	48.0	86	119	117	116	114	119	98	48	61	236	0	1089	.333
14	1753	1740	0.0	0.0	3.0	8.0	12.0	25.0	33.0	51.0	100	119	117	117	102	123	105	54	63	230	0	955	.333
15	1753	1762	19.5	0.0	3.5	7.5	11.5	28.0	34.0	49.5	92	118	115	113	109	119	105	53	56	238	980	1049	.333
16	1753	1746	20.0	0.0	4.5	5.0	10.0	28.0	38.0	58.0	96	124	124	125	85	125	106	29	81	217	975	893	1.000
17	1753	0	22.0	0.0	4.6	7.0	12.0	24.0	29.0	42.0	78	90	88	89	95	89	76	34	43	200	400	463	1.000
18	1755	1762	21.0	0.0	5.0	9.2	15.0	28.0	36.0	47.0	96	115	112	111	110	114	97	48	56	237	0	919	1.000
331	1755	1752	22.0	0.0	3.6	6.0	11.0	27.0	36.5	49.0	90	127	128	128	95	130	110	37	61	221	1035	1076	1.000
19	1756	0	24.0	0.0	3.5	7.0	9.5	32.0	38.0	55.0	102	163	0	0	110	160	114	36	62	260	2360	2095	1.000
20	1756	1754	21.0	0.0	4.7	6.3	13.0	26.0	34.0	53.0	92	132	129	128	100	130	109	52	59	230	0	1156	1.000
21	1756	0	21.4	0.0	4.7	7.5	11.0	24.0	29.0	40.0	91	87	86	86	90	87	72	30	53	205	400	403	1.000
23	1760	0	22.0	0.0	3.0	7.0	11.0	27.0	33.0	38.0	80	84	0	0	100	83	66	21	48	205	425	417	1.000
24	1761	1782	19.0	7.5	0.0	6.0	14.0	29.0	37.0	44.0	104	103	98	95	130	99	81	20	62	267	930	849	.500
332	1761	0	20.0	0.0	0.0	7.0	14.0	29.0	36.0	42.0	98	103	97	94	135	97	81	20	56	269	0	871	.500
333	1762	1754	20.0	0.0	3.0	6.0	9.4	27.0	34.0	48.0	91	110	107	105	110	105	88	43	67	232	850	782	.500
334	1762	1763	23.0	0.0	8.0	3.5	13.0	30.0	38.0	55.0	93	108	107	105	110	108	91	49	64	223	855	739	.500
25	1763	1773	24.0	6.0	0.0	5.0	11.5	27.0	33.0	50.0	100	104	97	97	123	103	91	32	58	250	850	819	1.000
26	1763	0	18.0	0.0	2.6	7.6	9.0	27.0	29.0	38.0	85	84	82	82	107	87	71	25	47	216	0	488	1.000
27	1763	0	21.0	0.0	6.0	8.0	13.0	30.0	37.0	53.0	95	153	150	150	140	154	141	52	66	275	0	2324	1.000
28	1764	1758	18.4	0.0	2.4	9.7	13.8	25.0	31.0	43.6	93	100	96	96	127	98	83	22	65	252	810	805	1.000
29	1764	1770	20.0	0.0	4.6	7.5	13.0	29.0	32.4	43.6	93	117	117	116	120	115	99	32	42	248	1130	1065	1.000
30	1764	1766	22.0	5.0	0.0	5.3	11.0	25.0	33.0	48.0	85	119	118	117	93	120	103	41	62	215	845	910	1.000
31	1765	0	23.0	0.0	0.0	6.5	11.0	33.0	40.0	52.0	103	149	146	147	127	147	130	31	69	281	2168	2088	1.000
32	1765	1761	21.4	0.0	3.0	5.7	9.5	28.5	36.0	52.0	85	121	121	121	115	120	103	29	61	235	0	1107	1.000
33	1765	0	0.0	0.0	0.0	0.0	0.0	28.5	35.0	42.0	98	119	116	116	125	114	95	10	79	260	0	1112	1.000
34	1765	1761	20.0	0.0	4.0	7.0	14.0	29.0	34.0	44.0	85	116	113	112	117	113	95	26	56	232	0	956	.333
35	1765	1772	21.0	0.0	5.0	6.5	12.0	25.0	32.6	48.0	78	114	112	112	109	115	109	26	60	219	945	935	.333
36	1765	1760	22.0	0.0	4.0	7.0	11.0	28.0	35.0	49.0	84	114	112	111	117	113	90	30	59	234	0	983	.333
37	1765	1777	22.0	0.0	4.7	7.5	13.0	30.0	37.0	49.0	72	115	112	111	114	113	91	21	61	230	1140	1056	.500
38	1765	1780	21.0	0.0	5.9	8.0	13.6	26.0	35.0	53.0	88	116	114	113	113	114	100	24	56	245	1050	1065	.500
39	1765	1772	21.0	5.0	0.0	7.0	11.3	28.0	36.0	50.0	90	120	118	118	110	119	103	42	58	234	0	1030	1.000
40	1765	1768	22.0	5.0	0.0	5.0	10.0	30.0	38.0	51.0	92	119	118	118	102	117	97	32	59	227	0	911	1.000
41	1766	0	21.0	0.0	0.0	4.0	9.0	29.0	36.0	50.0	95	121	120	119	117	118	101	34	56	250	0	1120	1.000
42	1767	1755	22.0	0.0	3.0	8.3	11.3	30.0	35.0	50.0	93	120	119	118	120	123	105	35	57	245	1120	1183	1.000
43	1767	1776	21.0	6.4	0.0	6.7	13.0	28.0	32.0	48.0	82	114	113	111	108	116	93	35	51	229	995	1007	1.000
44	1767	1771	23.0	7.0	0.0	7.0	13.5	27.0	36.0	49.0	92	120	0	0	110	119	100	35	57	232	1000	990	1.000
45	1768	1757	22.0	0.0	2.0	6.7	9.5	30.0	39.0	53.0	95	121	119	120	109	124	107	33	60	241	1085	1138	1.000
46	1769	1766	18.5	0.0	3.3	8.0	10.4	26.0	35.0	44.0	99	94	90	90	145	93	76	26	57	271	755	808	1.000
47	1769	0	22.0	5.0	0.0	4.0	10.0	29.0	37.0	48.0	94	118	117	114	152	121	103	28	53	285	1567	1568	1.000

AGE DISCRIMINATION OF ENGLISH WINE BOTTLES

BOT-TLE NO.	D A T E		BORE DIAM	LIP HT	LIP-STR RIM	STR RIM HT	FIN-ISH HT	NECK DIAM 1	NECK DIAM 2	NECK DIAM 3	NECK HT	BODY DIAM 1	BODY DIAM 2	BODY DIAM 3	BODY HT	BASE DIAM	REST PT DIAM	IN-DENT HT	PONT MARK DIAM	BOT-TLE HT	VOLUME		WGHT FACT
	ACTL	PRED																			ACTL	PRED	
48	1770	0	0.0	0.0	0.0	0.0	0.0	32.0	38.0	53.0	122	101	97	94	154	99	83	34	56	300	0	958	.333
49	1770	1770	22.7	0.0	3.0	7.5	11.3	29.0	36.0	43.0	115	101	97	94	145	99	82	38	51	298	0	996	.333
50	1770	0	21.0	0.0	0.0	6.6	11.3	29.0	36.0	49.0	110	100	96	93	145	97	80	31	56	291	910	942	.333
51	1770	1783	24.4	7.6	0.0	4.8	14.5	29.0	36.0	50.0	96	118	116	116	100	119	105	38	55	237	975	1000	1.000
52	1770	1786	22.4	6.6	0.0	7.0	12.0	27.0	32.0	42.0	97	94	93	93	140	93	81	17	42	262	0	764	.500
53	1770	1756	22.0	0.0	4.0	10.0	14.0	28.0	33.0	44.0	97	94	0	0	134	97	77	25	53	252	705	761	.500
54	1770	1778	21.0	4.5	0.0	4.0	9.5	28.0	35.0	46.5	103	99	97	95	130	98	84	38	50	264	820	819	1.000
55	1771	1772	23.0	0.0	5.8	6.0	11.5	28.0	36.0	48.0	83	120	117	116	108	120	104	35	55	227	1080	1047	1.000
56	1771	1767	24.0	0.0	2.5	5.5	8.0	29.0	37.0	50.0	91	121	118	117	120	119	101	28	59	254	1210	1220	1.000
57	1771	1789	22.6	5.0	0.0	3.7	10.0	29.0	35.0	43.0	78	112	109	108	120	110	95	31	59	242	0	1054	1.000
58	1771	0	0.0	0.0	0.0	0.0	0.0	0.0	35.0	42.0	95	95	93	92	145	95	78	25	53	268	0	850	.500
59	1771	0	23.0	0.0	0.0	7.5	14.0	29.0	33.0	41.0	92	94	92	92	139	94	81	28	55	269	769	859	.500
60	1772	1763	21.0	7.0	0.0	7.0	13.0	25.0	34.0	51.0	83	117	115	117	90	117	96	39	64	202	0	766	1.000
61	1773	1775	22.0	4.5	0.0	7.0	11.5	26.0	34.0	51.5	90	121	119	120	101	118	104	33	52	230	1045	974	1.000
62	1773	1784	24.7	5.5	0.0	6.0	10.5	29.0	39.0	56.0	91	122	120	120	98	123	108	29	50	232	1090	1067	1.000
63	1773	1782	24.0	6.4	0.0	4.4	13.0	31.0	36.0	46.0	107	99	96	93	140	96	84	20	53	273	0	20	1.000
64	1774	0	23.0	7.7	0.0	5.2	12.0	30.0	33.0	44.4	102	97	94	92	142	94	81	27	0	277	825	845	.500
65	1774	1775	22.0	4.2	0.0	7.5	12.0	31.0	37.0	45.0	106	97	93	92	151	95	77	25	49	281	900	863	.500
66	1774	1779	22.0	0.0	4.5	9.0	13.5	30.0	36.0	46.0	105	100	0	0	150	92	81	18	48	284	910	836	1.000
67	1775	0	25.0	0.0	0.0	3.1	10.0	28.0	35.0	43.0	97	95	93	93	140	94	82	27	51	277	820	879	1.000
68	1775	1784	21.0	5.2	0.0	4.7	11.0	28.0	35.0	47.0	77	118	114	113	110	119	100	25	54	232	1055	1139	1.000
69	1775	1777	23.0	5.5	0.0	8.0	14.5	29.0	35.0	49.0	86	119	117	116	115	118	99	27	56	239	1136	1100	1.000
70	1775	1783	23.0	4.0	0.0	5.7	10.0	29.5	33.5	39.5	103	101	97	95	150	95	80	24	53	290	925	946	1.000
71	1775	1778	20.0	3.5	0.0	6.2	8.0	29.0	35.0	50.0	78	119	114	114	114	115	94	17	56	236	1155	1093	1.000
72	1776	1796	25.0	6.0	0.0	4.3	10.5	31.0	38.0	49.0	92	101	97	95	139	97	81	26	46	267	903	899	1.000
73	1776	1776	22.0	4.0	0.0	6.5	10.0	31.0	39.0	49.0	80	120	117	116	118	117	96	32	53	232	0	1072	1.000
74	1776	1777	22.0	2.0	0.0	4.0	8.0	30.0	37.0	50.0	75	114	113	112	120	115	96	26	54	234	1087	1103	1.000
75	1776	1772	22.0	4.7	0.0	3.3	8.0	28.0	37.5	58.0	85	119	118	117	109	119	97	29	50	227	0	1010	1.000
76	1777	1784	21.5	4.4	0.0	3.0	8.0	29.0	34.0	44.0	76	107	107	104	120	106	90	27	47	231	915	907	1.000
77	1777	1776	21.0	4.5	0.0	6.3	10.5	29.0	33.0	45.0	91	120	118	118	113	119	100	29	46	245	1120	1129	1.000
78	1778	1790	23.0	6.0	0.0	4.0	11.5	32.0	39.0	51.0	75	122	120	119	111	118	99	27	59	231	0	1130	1.000
79	1779	1782	23.0	5.0	0.0	4.0	8.0	28.0	36.0	44.0	98	100	97	95	144	99	81	32	49	273	0	936	.200
80	1779	0	22.0	5.7	0.0	4.7	11.4	29.5	35.7	48.0	110	101	97	95	0	98	85	23	50	282	895	896	.200
81	1779	1784	22.0	4.4	0.0	6.0	11.0	29.0	35.0	47.0	94	99	96	96	145	97	80	32	50	272	839	921	.200
82	1779	1772	24.0	5.0	0.0	7.0	11.0	30.0	33.0	45.0	112	99	95	94	135	98	80	25	50	278	867	854	.200
83	1779	1782	21.0	6.0	0.0	5.0	11.6	30.0	36.0	47.0	104	100	96	94	142	97	78	29	51	278	867	892	.200
84	1780	1778	23.0	3.0	0.0	7.8	12.7	27.0	34.0	50.0	76	119	116	114	107	118	95	28	54	233	1075	1140	1.000
85	1780	1772	18.0	4.8	0.0	5.3	11.4	28.6	34.0	48.0	91	117	115	115	105	117	101	31	60	236	1025	1005	.500
86	1780	1776	24.0	6.0	0.0	6.0	13.5	31.0	38.0	54.0	90	117	114	114	117	117	98	31	61	242	0	1072	.500
87	1781	1761	0.0	0.0	3.0	7.4	9.4	28.0	34.0	46.0	117	94	91	90	154	92	76	40	50	295	0	830	1.000
88	1781	0	20.0	0.0	3.5	6.7	9.5	24.5	30.0	40.0	90	88	85	83	115	86	71	25	45	236	0	553	1.000
89	1781	1784	21.0	7.0	0.0	7.0	13.0	28.0	40.0	49.0	93	118	115	114	112	117	95	23	52	244	0	1063	1.000
90	1781	1766	20.0	0.0	2.0	10.0	12.0	29.0	35.0	48.0	80	119	116	116	100	118	105	29	56	221	0	984	1.000
92	1783	1779	20.0	2.0	0.0	7.0	9.0	29.0	37.0	47.0	74	118	116	115	112	118	99	26	52	229	1093	1120	.500
93	1783	1778	20.0	4.0	0.0	6.0	11.0	27.0	36.0	47.0	78	120	117	116	113	118	98	26	59	234	1155	1130	.500
94	1783	1782	21.0	3.3	0.0	5.0	10.8	29.0	37.0	47.0	77	106	103	102	122	104	85	35	48	233	855	881	1.000
95	1783	1771	21.5	6.0	0.0	4.0	11.0	26.0	32.0	43.0	102	119	0	0	105	115	94	22	51	248	1049	981	1.000
96	1783	1785	25.0	0.0	6.0	6.0	13.0	31.0	36.0	43.0	86	98	0	0	152	93	72	22	55	273	795	907	1.000
97	1784	0	23.0	0.0	0.0	0.0	10.0	29.0	35.0	44.0	95	93	90	87	150	90	77	25	55	273	0	794	1.000
98	1784	0	25.0	0.0	0.0	4.8	13.5	35.0	45.0	57.0	105	160	156	155	175	158	137	31	69	330	0	3321	.500

AGE DISCRIMINATION OF ENGLISH WINE BOTTLES

BOT-TLE NO	D A T E ACTL	D A T E PRED	BORE DIAM	LIP HT	LIP-STR RIM	STR RIM HT	FIN-ISH HT	NECK DIAM 1	NECK DIAM 2	NECK DIAM 3	NECK HT	BODY DIAM 1	BODY DIAM 2	BODY DIAM 3	BODY HT	BASE DIAM	REST PT DIAM	IN-DENT HT	PONT MARK DIAM	BOT-TLE HT	VOLUME ACTL	VOLUME PRED	WGHT FACT
99	1784	0	28.0	7.5	0.0	8.0	15.5	36.0	45.0	56.0	106	164	0	0	175	156	140	32	70	338	3229	3378	.500
100	1784	1787	21.0	4.0	0.0	7.5	11.0	29.0	37.0	47.0	72	119	115	115	105	116	96	26	54	225	1055	1064	1.000
101	1784	1802	28.0	8.0	0.0	8.0	16.0	30.0	36.0	40.0	80	96	92	90	152	93	78	22	56	265	0	894	1.000
102	1785	0	20.0	0.0	0.0	5.7	8.0	30.0	34.0	39.6	89	98	95	95	137	95	81	41	53	257	0	816	1.000
103	1785	1774	19.4	5.0	0.0	4.7	13.0	28.0	34.0	42.0	95	118	116	116	112	114	98	28	59	246	0	1010	1.000
104	1785	1781	22.4	6.1	0.0	5.1	12.0	27.0	34.6	37.6	103	96	94	94	137	97	83	38	49	267	781	823	.333
105	1785	1783	20.0	7.0	0.0	5.0	12.0	27.0	32.0	38.0	102	97	73	92	135	97	82	45	47	267	0	830	.333
106	1785	0	20.5	0.0	0.0	5.7	11.4	27.0	32.0	38.0	101	97	94	93	140	95	80	30	51	273	805	843	.333
107	1785	0	24.0	0.0	0.0	4.5	14.5	29.0	37.0	49.0	88	117	116	114	123	115	100	26	55	264	1310	1268	1.000
108	1785	1776	23.0	5.0	0.0	9.2	13.0	31.0	38.0	52.0	91	118	114	113	112	116	95	31	57	242	970	1045	1.000
109	1786	1774	24.0	4.0	0.0	0.0	10.7	30.0	38.0	49.0	81	122	119	117	115	122	97	37	61	239	0	1228	1.000
110	1786	1783	19.5	4.0	0.0	6.5	11.0	30.0	36.0	47.0	108	101	97	95	146	101	83	30	53	295	950	1067	1.000
111	1786	1773	21.0	0.0	5.0	4.8	8.5	27.0	34.0	50.0	94	119	117	117	110	117	100	35	48	247	1090	1082	1.000
112	1787	1799	24.0	7.8	0.0	8.0	16.0	29.0	38.0	43.0	82	93	89	89	152	94	76	29	55	265	0	899	1.000
113	1787	0	23.0	7.5	0.0	5.0	13.0	34.0	42.0	50.0	108	120	117	115	170	117	105	34	61	314	1535	1628	1.000
114	1788	1783	23.0	4.2	0.0	5.8	9.3	33.0	37.0	48.0	70	118	115	114	98	116	98	38	56	211	1015	951	1.000
115	1788	1786	24.0	7.0	0.0	4.0	12.0	30.0	34.0	42.0	87	100	0	0	140	98	83	42	44	250	750	833	.500
116	1788	1798	23.0	8.0	0.0	6.0	14.0	31.0	38.0	42.0	91	96	92	90	129	98	84	43	47	253	769	826	.500
117	1789	1783	23.0	3.3	0.0	5.7	12.4	27.6	33.3	47.0	79	117	114	114	110	115	94	35	51	240	1095	1122	1.000
118	1790	1787	20.0	4.0	0.0	9.0	13.0	29.0	34.0	45.0	91	92	90	88	147	89	73	26	52	273	0	801	1.000
119	1790	0	19.0	6.0	0.0	6.0	12.2	29.0	34.0	43.6	85	118	114	113	110	0	0	0	53	235	1105	0	1.000
120	1791	0	19.0	6.0	0.0	8.0	14.0	24.0	31.0	34.0	64	62	61	63	97	65	50	13	33	180	192	232	.500
121	1791	0	20.0	4.0	0.0	6.7	12.0	24.5	27.0	28.0	58	62	61	61	100	63	51	14	39	179	250	232	.500
122	1791	1771	26.0	6.0	0.0	8.0	13.0	29.0	33.0	50.0	107	0	0	0	150	97	80	22	54	279	0	878	1.000
123	1791	1795	17.0	7.1	0.0	5.0	11.5	27.4	33.9	47.0	79	114	112	111	114	111	93	23	52	240	1065	1046	1.000
124	1792	1790	18.6	5.3	0.0	4.4	9.6	27.0	34.5	47.0	75	107	105	103	128	105	89	26	52	241	1010	978	1.000
125	1793	0	24.0	8.0	0.0	6.5	15.0	31.0	42.0	53.0	85	117	114	111	177	112	92	27	64	304	1740	1625	1.000
126	1793	1794	25.0	7.7	0.0	5.0	13.4	28.0	35.0	44.0	93	95	92	91	143	96	81	37	53	270	845	895	.500
127	1793	1791	21.0	6.8	0.0	4.0	12.0	27.0	38.0	44.0	103	95	93	91	147	95	80	28	52	281	0	884	.500
128	1793	1793	23.5	10.0	0.0	4.6	15.0	31.0	36.0	53.0	74	113	112	113	111	116	97	33	54	221	0	1007	1.000
129	1793	1788	23.5	5.4	0.0	5.4	10.8	30.0	38.0	53.0	87	113	110	99	115	114	97	26	55	246	1055	1084	1.000
130	1793	1769	17.4	1.4	0.0	8.0	8.8	30.0	34.0	48.0	95	117	114	113	111	116	98	24	55	252	1135	1102	.500
131	1793	1785	22.0	4.0	0.0	4.0	9.5	29.0	37.0	47.6	89	119	116	115	117	116	101	29	57	253	1225	1170	.500
132	1793	1788	22.0	6.8	0.0	5.8	12.7	31.0	35.0	43.0	110	100	97	96	138	98	83	25	55	287	880	932	1.000
134	1793	1806	22.5	6.0	0.0	6.5	14.0	29.0	36.6	40.0	83	91	90	90	149	92	78	41	50	273	0	907	.500
135	1793	1798	24.0	7.0	0.0	7.0	14.0	27.0	34.0	43.0	78	92	89	90	149	92	77	37	54	260	0	855	.500
136	1794	1799	20.0	7.0	0.0	5.3	13.7	29.0	35.0	45.0	91	93	89	88	147	92	80	31	48	271	0	842	.166
137	1794	1796	20.0	7.0	0.0	3.4	11.7	30.0	34.0	45.0	90	93	90	89	142	92	78	35	49	266	775	817	.166
138	1794	1801	20.0	8.0	0.0	5.5	15.7	28.0	33.0	40.0	86	93	90	88	142	93	79	22	51	266	840	851	.166
139	1794	1805	20.0	12.0	0.0	4.0	16.0	28.0	34.0	43.0	103	93	89	88	146	95	80	20	53	285	0	911	.166
140	1794	1790	20.0	8.5	0.0	3.8	12.1	29.0	34.0	44.4	109	94	91	89	150	93	76	33	50	291	867	874	.166
141	1794	1795	19.0	7.4	0.0	2.0	11.0	28.0	34.0	40.0	92	93	91	89	145	93	77	29	52	272	800	861	.166
142	1794	0	22.0	6.0	0.0	5.0	11.0	25.0	32.0	38.0	58	76	0	0	115	77	62	19	44	196	350	412	1.000
143	1795	1801	23.0	8.0	0.0	4.0	12.5	31.0	38.0	46.0	61	117	116	116	110	117	100	29	53	213	1025	1072	1.000
145	1795	1789	23.0	7.2	0.0	6.0	15.0	29.0	35.0	47.0	92	113	110	109	113	109	93	14	61	251	1051	992	1.000
144	1796	1799	24.0	6.5	0.0	5.0	12.5	29.0	35.0	41.0	75	98	0	0	132	92	81	30	47	237	675	729	1.000
336	1796	1797	21.0	6.0	0.0	3.4	12.5	30.0	39.0	49.0	74	117	115	115	110	116	102	30	53	228	1085	1074	.250
337	1796	1789	18.0	7.0	0.0	5.8	10.0	28.0	34.0	43.0	77	118	115	115	105	115	98	39	52	225	995	999	.250
338	1796	1784	21.0	7.0	0.0	3.0	10.0	27.0	36.0	45.0	85	114	111	110	120	114	99	30	56	239	1055	1037	.250
339	1796	1791	19.0	7.0	0.0	5.0	11.2	29.5	35.0	44.0	78	115	111	111	120	113	98	38	50	235	0	1047	.250

AGE DISCRIMINATION OF ENGLISH WINE BOTTLES

BOTTLE NO	DATE		BORE DIAM	LIP HT	LIP-STR RIM	STR RIM HT	FINISH HT	NECK DIAM 1	NECK DIAM 2	NECK DIAM 3	NECK HT	BODY DIAM 1	BODY DIAM 2	BODY DIAM 3	BODY HT	BASE DIAM	REST PT DIAM	INDENT HT	PONT MARK DIAM	BOTTLE HT	VOLUME		WGHT FACT
	ACTL	PRED																			ACTL	PRED	
146	1797	1801	17.5	7.0	0.0	4.0	14.0	28.0	39.0	51.0	89	100	96	94	142	95	77	27	47	268	0	891	1.000
147	1798	0	24.6	0.0	0.0	9.9	15.3	34.0	39.0	49.0	68	121	119	118	117	119	98	28	63	233	1250	1241	1.000
148	1799	1793	21.0	9.4	0.0	7.0	16.0	28.0	36.0	50.0	81	114	113	110	110	114	96	22	56	231	1065	1001	1.000
149	1800	1821	20.0	12.0	0.0	6.0	17.0	29.0	36.0	38.0	76	86	85	84	164	87	73	32	50	271	0	842	1.000
150	1800	1800	23.0	10.7	0.0	3.8	14.3	28.0	37.0	47.5	90	115	113	112	120	113	93	26	56	255	1180	1121	1.000
151	1800	1803	20.0	8.0	0.0	4.3	13.3	29.5	34.0	40.0	87	94	90	87	142	91	80	23	50	264	0	806	1.000
152	1800	1793	22.0	6.6	0.0	2.8	12.0	25.0	33.0	40.0	84	90	86	83	150	86	70	29	51	263	0	732	1.000
153	1801	1799	22.0	8.0	0.0	5.0	12.0	32.0	37.0	38.0	92	95	91	87	155	92	79	25	50	275	0	862	1.000
154	1801	0	21.0	0.0	0.0	7.0	16.0	30.0	36.0	44.0	88	91	0	0	161	90	0	42	54	272	785	831	1.000
155	1802	1791	26.0	6.2	0.0	5.0	11.6	33.0	37.0	49.0	77	114	113	113	117	110	91	31	53	235	0	1002	1.000
156	1802	1797	22.0	11.0	0.0	4.0	14.0	27.0	35.0	45.0	80	114	112	111	115	113	95	24	63	237	1120	1047	1.000
157	1803	1797	22.0	11.0	0.0	5.0	16.2	28.0	35.0	46.0	88	114	112	111	125	113	98	32	58	251	0	1102	1.000
158	1805	1808	22.0	11.0	0.0	8.0	19.0	27.0	35.0	42.0	96	91	88	81	159	86	72	33	41	281	0	766	1.000
159	1806	1800	23.0	7.0	0.0	4.7	11.1	28.0	35.0	46.0	63	107	105	103	125	104	89	24	49	224	950	920	1.000
160	1807	1803	20.0	11.0	0.0	5.0	15.5	30.0	35.0	46.6	62	116	113	112	107	115	91	26	47	211	0	1009	1.000
161	1808	0	24.0	6.5	0.0	5.0	12.0	31.0	40.0	51.0	79	136	134	132	114	132	114	37	47	240	0	1472	1.000
162	1809	1806	21.5	7.6	0.0	7.0	15.0	30.0	39.5	42.0	77	109	106	104	118	108	94	47	43	235	0	966	.250
163	1809	1814	22.0	9.0	0.0	7.0	16.0	32.0	41.0	47.0	72	109	107	105	125	108	93	46	51	241	0	1059	.250
164	1809	1807	23.0	7.3	0.0	6.0	16.0	32.0	40.0	43.5	75	110	108	107	126	108	94	46	47	242	0	1042	.250
165	1809	0	23.5	6.0	0.0	7.5	15.5	32.0	41.0	45.0	75	110	107	106	120	108	93	51	0	240	0	1025	.250
166	1809	1813	21.0	9.0	0.0	7.0	15.0	29.0	35.0	41.0	70	88	85	83	153	89	72	35	49	260	0	850	1.000
167	1810	1816	23.0	12.0	0.0	3.0	16.0	29.0	35.0	42.0	79	90	86	82	160	85	72	29	57	270	0	782	1.000
168	1811	1794	23.0	8.5	0.0	6.0	16.0	32.5	41.0	47.0	81	121	118	0	97	118	98	46	59	223	0	993	1.000
169	1813	1804	22.0	8.0	0.0	6.0	13.0	28.0	35.0	42.0	78	95	0	0	160	90	77	31	51	266	880	856	1.000
171	1814	1816	22.0	10.8	0.0	6.8	17.5	32.9	39.0	48.0	70	108	106	104	135	107	91	36	50	245	1045	1091	1.000
172	1815	1811	27.4	8.0	0.0	8.0	17.0	31.0	36.0	42.5	81	90	86	84	170	88	76	25	50	283	835	904	.333
173	1815	1804	22.0	8.6	0.0	5.7	15.0	29.0	35.0	41.6	85	89	86	84	170	87	73	26	49	281	0	848	.333
174	1815	1801	20.5	9.0	0.0	5.0	15.0	27.0	35.0	39.0	90	90	87	86	172	88	75	26	50	284	0	855	.333
175	1815	1810	21.0	10.0	0.0	7.0	18.0	30.0	35.0	45.0	66	108	106	106	139	107	90	34	54	246	1150	1134	1.000
177	1817	1800	23.0	7.5	0.0	7.5	18.0	31.0	36.0	44.0	84	91	87	85	154	88	72	30	55	270	810	807	.500
178	1817	1802	22.0	8.0	0.0	5.0	14.0	29.0	33.0	42.0	84	89	86	84	170	86	71	83	50	283	850	847	1.000
179	1817	1804	22.0	9.6	0.0	9.0	20.0	30.0	35.0	40.0	87	91	88	85	158	89	76	30	52	273	0	825	.500
180	1818	1808	20.6	10.5	0.0	8.0	18.0	31.0	37.0	45.5	70	108	106	104	135	106	91	36	55	240	0	1029	.500
181	1818	1807	20.0	13.0	0.0	8.0	20.0	32.0	37.0	49.0	71	108	106	104	136	105	87	35	60	238	0	986	.500
182	1819	1808	21.0	11.0	0.0	6.0	16.6	30.0	37.0	44.0	81	90	88	86	168	87	72	23	50	269	845	801	1.000
183	1820	1816	20.0	11.6	0.0	6.0	19.3	35.0	40.0	46.0	80	110	108	106	134	106	90	40	49	254	1115	1063	1.000
184	1820	1830	23.0	20.0	0.0	4.0	23.0	30.0	35.0	47.0	75	111	110	110	127	109	93	37	65	246	0	1096	1.000
185	1821	0	23.0	12.0	0.0	5.0	18.6	33.0	42.0	53.0	95	116	113	111	168	111	95	33	70	302	1470	1477	1.000
186	1822	1809	22.6	9.8	0.0	5.5	15.0	30.0	36.0	47.5	79	108	106	104	133	106	89	30	52	257	1085	1097	1.000
187	1822	1819	19.0	15.0	0.0	4.0	18.0	28.0	34.0	42.0	74	100	98	99	116	97	87	21	52	224	768	728	1.000
188	1822	0	20.0	17.0	0.0	4.0	21.0	29.0	36.0	41.0	85	97	96	95	149	88	0	21	50	0	0	0	1.000
189	1823	1830	22.0	16.0	0.0	3.5	19.0	31.0	38.0	47.0	78	107	104	0	142	102	92	17	58	259	0	1040	.500
190	1823	1819	20.0	14.0	0.0	3.0	18.0	31.0	35.0	47.0	84	107	104	102	143	104	94	18	57	266	0	1089	.500
191	1823	0	23.0	15.0	0.0	7.0	22.0	33.0	43.0	62.0	88	141	141	142	138	143	120	28	63	289	0	2337	1.000
192	1823	0	24.0	15.0	0.0	8.0	22.0	34.0	42.0	55.0	90	143	142	140	147	140	114	33	67	301	2335	2396	1.000
193	1825	1826	18.0	14.0	0.0	6.0	22.0	29.0	36.0	43.0	83	103	100	100	159	102	91	21	48	279	0	1160	1.000
194	1826	1811	21.0	12.0	0.0	6.0	18.0	30.0	37.0	46.0	78	108	105	106	138	107	92	26	49	250	0	1066	.500
195	1826	1825	20.0	15.0	0.0	5.0	22.0	31.0	35.0	47.0	75	109	0	0	127	104	92	21	50	243	1027	976	.500
196	1827	1826	17.0	16.0	0.0	5.0	20.0	28.0	34.0	43.0	92	88	86	83	155	84	80	17	52	273	0	710	1.000
197	1828	1819	19.0	11.7	0.0	7.6	19.0	27.0	34.0	41.0	96	87	83	83	150	83	72	31	50	286	760	741	1.000

AGE DISCRIMINATION OF ENGLISH WINE BOTTLES

BOT- TLE NO.	DATE ACTL	DATE PRED	BORE DIAM	LIP HT	LIP- STR RIM	STR RIM HT	FIN- ISH HT	NECK DIAM 1	NECK DIAM 2	NECK DIAM 3	NECK HT	BODY DIAM 1	BODY DIAM 2	BODY DIAM 3	BODY HT	BASE DIAM	REST PT DIAM	IN- DENT HT	PONT MARK DIAM	BOT- TLE HT	VOLUME ACTL	VOLUME PRED	WGHT FACT
198	1829	1834	19.0	17.0	0.0	5.0	22.0	29.5	34.6	41.5	94	90	87	84	151	84	79	21.	50.	278	790	726	1.000
199	1834	1839	20.0	15.7	0.0	7.0	22.0	28.6	35.4	42.0	95	89	86	0	160	84	82	27.	51.	293	0	803	1.000
200	1836	1833	19.0	16.0	0.0	6.0	22.0	31.0	37.0	44.0	84	107	105	105	142	103	98	19.	53.	265	1137	1060	1.000
201	1836	1842	20.0	18.0	0.0	6.0	24.0	33.0	37.0	45.0	81	107	105	103	143	104	100	18.	47.	262	1160	1081	1.000
202	1836	1817	19.0	10.0	0.0	5.0	16.0	26.0	34.0	36.0	87	83	82	0	151	83	76	13.	46.	272	0	714	1.000
203	1837	0	18.0	13.0	0.0	6.6	19.0	25.0	29.0	34.0	73	69	67	0	120	67	63	22.	49.	224	0	354	1.000
204	1838	1833	20.0	16.0	0.0	7.0	24.0	31.0	35.0	40.0	91	89	86	85	154	84	82	18.	49.	275	770	726	1.000
205	1840	1834	20.0	16.3	0.0	5.5	22.6	30.0	34.0	39.0	94	89	87	86	146	84	78	20.	46.	277	750	720	.500
206	1840	1827	19.0	16.0	0.0	5.6	22.0	31.0	34.0	39.0	92	89	88	85	146	85	79	15.	51.	270	0	710	.500
207	1846	0	20.0	22.0	0.0	6.0	28.0	29.0	33.0	40.0	102	87	86	83	150	84	0	19.	50.	283	0	710	1.000
208	1858	0	21.0	14.0	0.0	6.0	21.0	28.0	43.0	48.0	107	116	115	112	145	0	99	32.	0.	303	1495	0	1.000
10	0	1755	20.0	0.0	4.0	7.5	11.5	28.0	35.0	47.0	75	128	128	128	80	128	108	46.	60.	192	860	894	1.000
91	0	1780	21.0	5.0	0.0	4.0	12.0	27.0	34.0	42.0	87	94	0	0	152	93	75	27.	58.	266	776	854	1.000
133	0	1790	23.0	8.0	0.0	5.0	13.0	32.0	37.0	44.0	109	98	0	0	133	97	82	37.	38.	270	738	802	1.000
170	0	0	21.0	5.5	0.0	11.5	18.0	32.5	40.0	58.0	95	146	0	0	125	140	124	29.	46.	280	0	2000	1.000
176	0	0	22.0	11.0	0.0	9.0	21.0	29.0	37.0	42.0	88	99	94	91	153	96	0	24.	58.	280	0	1001	1.000
209	0	1827	18.0	16.0	0.0	7.5	21.5	31.0	37.0	47.0	90	107	104	102	145	103	93	25.	50.	272	1160	1068	1.000
210	0	0	21.0	15.0	0.0	6.0	21.5	0.0	0.0	0.0	94	0	0	0	153	83	81	21.	0.	277	769	704	1.000
211	0	0	16.0	13.0	0.0	5.0	19.0	24.0	29.0	35.0	72	74	0	0	121	72	0	15.	38.	216	370	383	1.000
212	0	0	17.0	13.4	0.0	5.0	18.5	25.0	29.4	35.0	70	73	72	0	118	71	65	20.	40.	214	0	372	1.000
213	0	0	20.0	16.0	0.0	7.0	21.5	29.0	35.0	41.0	95	89	86	83	152	85	0	17.	50.	274	0	715	1.000
214	0	0	19.0	15.0	0.0	4.0	19.0	32.0	35.0	41.0	75	100	98	98	117	98	0	20.	50.	227	0	756	1.000
215	0	0	20.0	18.0	0.0	6.0	24.0	33.0	37.0	47.0	81	108	107	102	143	104	0	20.	5[illegible]	260	0	1064	1.000
216	0	1840	19.6	16.0	0.0	7.0	22.0	30.0	35.0	44.0	83	101	99	97	159	98	92	24.	49.	284	1130	1110	1.000
217	0	1825	21.0	16.0	0.0	6.0	22.0	29.0	36.0	43.0	82	100	98	0	117	97	95	20.	56.	232	795	728	1.000
218	0	0	21.5	20.4	0.0	6.5	28.0	27.0	32.5	40.0	103	86	84	81	153	82	72	11.	0.	288	760	697	1.000
219	0	0	22.4	21.0	0.0	6.0	28.0	29.0	34.0	42.5	87	98	97	0	120	96	85	11.	0.	241	800	739	1.000
220	0	0	20.0	0.0	3.5	7.7	12.0	26.0	32.0	42.0	84	102	100	101	78	101	87	38.	56.	190	475	489	1.000
221	0	1774	20.0	0.0	4.0	4.0	10.0	27.0	35.0	49.0	74	108	106	104	120	107	92	34.	49.	224	870	883	1.000
222	0	1767	19.0	0.0	4.5	5.8	10.0	27.4	37.0	58.0	92	129	126	124	87	126	105	38.	37.	220	0	980	1.000
223	0	1753	21.0	0.0	2.0	6.4	8.4	28.5	33.0	48.0	85	110	108	106	115	109	93	36.	59.	227	905	850	1.000
224	0	1762	22.0	0.0	6.5	4.3	12.0	25.0	32.0	46.0	111	101	98	96	120	101	86	32.	55.	259	0	774	1.000
225	0	1761	23.5	0.0	4.0	9.0	13.5	27.0	34.5	48.0	101	103	100	98	120	100	84	41.	57.	250	815	766	1.000
226	0	1771	18.0	0.0	6.0	4.6	11.0	27.0	34.0	45.0	82	105	103	101	120	104	86	31.	56.	232	843	835	1.000
227	0	1769	21.5	0.0	4.0	6.5	10.0	26.0	36.0	48.0	85	112	109	107	105	108	92	37.	55.	225	865	818	1.000
228	0	1764	22.0	0.0	2.6	5.0	8.4	28.0	33.0	41.0	75	105	102	101	115	105	88	32.	56.	222	795	828	1.000
229	0	1755	21.0	0.0	4.0	9.0	16.0	26.0	31.0	41.0	107	101	99	96	133	97	82	37.	57.	264	830	775	1.000
230	0	1752	21.0	0.0	4.4	8.0	14.0	26.0	30.0	35.0	107	101	98	96	127	96	80	19.	64.	260	775	733	1.000
231	0	1765	29.0	0.0	7.6	5.5	9.5	29.0	31.0	39.0	107	93	90	91	121	95	71	26.	32.	250	680	654	1.000
232	0	0	19.0	0.0	5.5	7.5	10.0	0.0	0.0	0.0	80	0	0	0	115	107	95	30.	0.	233	828	907	1.000
233	0	0	20.0	0.0	0.0	0.0	11.5	0.0	0.0	0.0	88	0	0	0	105	105	93	34.	0.	216	828	684	1.000
234	0	0	22.0	0.0	6.0	6.5	9.5	0.0	0.0	0.0	79	0	0	0	115	104	88	37.	0.	226	769	812	1.000
235	0	0	24.0	0.0	0.0	5.5	13.0	27.0	35.0	45.0	87	111	108	107	110	108	90	38.	60.	229	825	834	1.000
236	0	1778	22.0	6.0	0.0	3.6	9.6	28.0	34.0	40.0	81	104	101	100	120	104	85	29.	68.	237	855	881	1.000
237	0	1790	23.0	7.0	0.0	5.0	14.0	26.0	36.0	45.0	62	108	106	107	100	107	89	27.	69.	204	780	819	1.000
238	0	0	21.0	0.0	0.0	4.0	13.6	27.0	37.0	45.0	79	111	104	102	115	106	86	52.	59.	217	830	773	1.000
239	0	1773	19.6	3.5	0.0	4.0	9.0	27.0	35.0	50.0	85	109	104	102	130	106	90	45.	48.	240	870	907	1.000
240	0	1779	22.0	5.0	0.0	4.0	9.0	29.0	35.0	40.0	83	106	102	101	115	102	82	24.	58.	235	845	818	1.000
241	0	0	21.0	0.0	0.0	6.0	11.0	25.0	32.0	49.0	80	116	112	112	93	112	95	35.	58.	203	790	736	1.000
242	0	0	21.0	0.0	0.0	6.0	11.0	26.0	34.0	42.0	100	98	94	93	117	97	84	34.	56.	240	690	662	1.000

AGE DISCRIMINATION OF ENGLISH WINE BOTTLES

BOT-TLE NO	D A T E		BORE DIAM	LIP HT	LIP-STR RIM	STR RIM HT	FIN-ISH HT	NECK DIAM 1	NECK DIAM 2	NECK DIAM 3	NECK HT	BODY DIAM 1	BODY DIAM 2	BODY DIAM 3	BODY HT	BASE DIAM	REST PT DIAM	IN-DENT HT	PONT MARK DIAM	BOT-TLE HT	VOLUME		WGHT FACT
	ACTL	PRED																			ACTL	PRED	
243	0	1769	18.0	7.0	0.0	7.0	16.0	27.0	35.0	51.0	101	105	101	100	130	104	87	36	62	254	860	858	1.000
244	0	1771	19.0	6.4	0.0	5.0	12.0	28.0	35.0	48.0	81	108	105	103	115	107	80	25	64	230	880	875	1.000
245	0	0	21.0	0.0	0.0	4.0	11.4	27.6	33.0	42.0	96	92	89	87	150	90	74	34	56	0	737	0	1.000
246	0	1779	21.0	5.4	0.0	7.0	13.0	27.0	33.0	42.0	65	108	106	105	97	106	88	27	56	196	750	720	1.000
247	0	1777	22.0	7.0	0.0	5.6	13.0	28.0	32.0	42.0	105	96	93	90	135	94	79	43	53	266	720	754	1.000
248	0	1778	23.0	6.0	0.0	10.0	16.0	28.0	34.0	44.0	105	92	91	91	150	95	78	34	51	280	825	863	1.000
249	0	1773	22.0	4.0	0.0	6.0	11.0	29.0	36.0	43.0	81	105	103	101	105	103	86	23	56	216	775	709	1.000
250	0	0	0.0	7.0	0.0	4.0	11.0	29.0	37.0	41.0	101	104	101	101	112	106	93	40	0	244	795	812	1.000
251	0	0	23.0	0.0	0.0	9.0	13.0	30.0	38.0	49.0	96	121	0	0	125	118	109	29	63	250	0	1110	1.000
252	0	0	23.0	5.0	0.0	13.0	15.0	30.0	35.0	42.0	0	104	102	101	116	100	84	36	54	218	815	0	1.000
253	0	1790	21.0	4.0	0.0	4.7	11.9	30.0	35.0	41.0	74	98	93	93	126	96	81	40	48	235	760	786	1.000
254	0	0	22.0	7.0	0.0	5.0	12.0	30.0	36.0	42.0	90	97	95	92	130	95	80	52	0	253	0	783	1.000
255	0	1786	24.0	7.0	0.0	5.5	14.0	29.0	36.0	39.0	84	102	99	100	111	100	84	30	48	224	720	703	1.000
256	0	1797	20.0	8.0	0.0	8.0	16.0	27.0	33.0	38.0	88	90	88	86	146	91	74	40	44	265	730	806	1.000
257	0	0	25.0	8.0	0.0	2.8	10.0	32.0	42.0	55.0	88	146	140	138	131	140	113	22	60	277	2225	2060	1.000
258	0	1800	24.0	7.4	0.0	5.0	15.0	30.0	38.0	42.5	92	92	88	87	154	89	76	30	52	275	780	807	1.000
259	0	1795	20.0	8.0	0.0	4.5	15.5	30.0	36.0	39.0	84	88	88	86	150	89	76	31	57	258	715	753	1.000
260	0	1803	22.7	10.0	0.0	6.0	19.0	29.0	37.0	43.0	73	98	96	95	122	99	86	38	61	229	760	800	1.000
261	0	1795	22.0	9.2	0.0	4.0	19.0	31.0	37.0	41.0	70	102	99	98	127	99	84	22	61	224	855	786	1.000
262	0	1796	21.0	9.0	0.0	5.0	19.7	31.0	40.0	47.0	86	98	95	94	130	97	81	40	59	246	800	795	1.000
263	0	1800	22.0	8.6	0.0	6.0	18.2	29.0	37.0	45.0	70	98	93	93	125	97	84	36	58	226	790	768	1.000
264	0	1796	22.0	8.0	0.0	5.6	15.6	31.0	37.0	42.0	75	99	97	97	117	97	82	31	55	225	710	728	1.000
265	0	1806	23.0	8.0	0.0	6.0	15.0	29.0	38.0	42.0	80	91	89	86	150	89	74	33	52	262	780	801	1.000
266	0	1809	21.0	9.0	0.0	5.0	16.0	29.0	32.0	38.0	78	91	86	82	143	86	73	29	52	259	740	743	1.000
267	0	1793	18.0	10.1	0.0	7.0	19.5	26.0	33.0	37.0	99	91	89	87	145	92	80	23	58	271	740	791	1.000
268	0	0	22.0	9.0	0.0	11.0	18.0	0.0	0.0	0.0	0	0	0	0	152	87	71	39	44	267	784	0	1.000
269	0	0	20.0	8.0	0.0	6.0	14.0	0.0	0.0	0.0	81	0	0	0	110	99	83	34	0	223	739	703	1.000
270	0	1793	21.0	7.6	0.0	6.0	15.5	28.0	37.0	42.0	81	97	96	93	125	94	78	35	42	230	760	678	1.000
271	0	1809	21.5	12.0	0.0	5.0	20.0	29.0	37.0	42.0	75	97	96	96	130	97	81	40	64	242	788	844	1.000
272	0	1816	20.0	11.0	0.0	7.0	20.0	28.0	37.0	40.0	77	86	84	82	150	85	72	44	53	258	700	726	1.000
273	0	1813	19.0	12.0	0.0	3.0	16.0	27.0	37.0	36.0	78	94	93	0	127	90	79	47	51	235	720	669	1.000
274	0	1803	22.0	10.0	0.0	6.0	17.0	28.0	40.0	42.0	87	95	93	92	127	95	80	43	57	247	765	763	1.000
275	0	1802	23.0	11.0	0.0	6.5	17.5	29.0	38.0	43.0	80	100	99	98	115	100	86	34	63	230	785	773	1.000
276	0	1808	24.0	13.0	0.0	4.0	16.2	31.0	37.0	47.0	80	109	107	106	140	109	90	25	55	255	0	1132	1.000
277	0	1799	22.0	8.0	0.0	5.0	13.0	29.0	36.0	44.0	85	95	0	0	152	91	75	22	51	266	850	831	1.000
278	0	0	19.0	10.0	0.0	5.0	15.5	28.0	36.0	43.0	86	118	112	109	180	111	95	33	51	315	0	1697	1.000
279	0	1815	20.0	13.0	0.0	4.0	16.0	27.0	40.0	44.0	86	99	96	95	115	96	85	49	63	240	765	739	1.000
280	0	1795	24.0	8.0	0.0	4.0	11.0	29.0	36.0	45.0	75	115	112	112	125	113	98	27	57	238	1075	1102	1.000
281	0	0	20.0	12.0	0.0	4.0	15.5	0.0	0.0	0.0	87	0	0	0	168	80	70	37	0	290	739	754	1.000
282	0	0	22.0	9.0	0.0	7.0	18.0	29.0	38.0	38.0	82	0	83	78	165	85	70	41	57	0	0	0	1.000
283	0	1811	21.5	9.4	0.0	4.0	13.5	30.0	37.0	39.0	75	86	83	83	165	89	75	44	48	266	755	856	1.000
284	0	1801	20.0	10.0	0.0	7.5	17.0	29.0	38.0	44.0	80	100	96	94	122	96	81	38	65	238	785	766	1.000
285	0	1818	20.0	13.0	0.0	7.0	22.0	31.0	38.0	40.0	74	100	95	92	125	94	78	48	52	235	790	754	1.000
286	0	1807	24.0	9.0	0.0	4.0	15.0	30.0	37.0	41.0	75	89	87	85	143	88	74	39	55	249	730	737	1.000
287	0	1818	19.0	10.0	0.0	3.0	13.0	26.0	37.0	40.0	80	87	85	85	165	85	72	51	52	279	800	827	1.000
288	0	0	18.0	9.0	0.0	9.0	19.0	0.0	0.0	0.0	68	0	0	0	137	93	80	33	53	227	710	726	1.000
289	0	1795	22.0	8.0	0.0	7.0	14.5	26.0	31.6	38.0	93	90	87	84	152	86	76	37	57	274	0	743	1.000
290	0	1795	19.0	10.0	0.0	6.5	19.5	30.0	37.0	43.0	85	98	96	95	123	97	79	37	61	241	810	768	1.000
291	0	0	17.0	5.0	0.0	2.4	10.0	27.0	32.0	34.0	67	78	74	73	125	75	63	25	44	221	450	455	1.000
292	0	1804	21.0	11.0	0.0	4.0	16.0	28.0	39.0	48.0	82	99	97	96	128	99	84	42	62	244	832	842	1.000

AGE DISCRIMINATION OF ENGLISH WINE BOTTLES

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BOT-   D A T E BORE  LIP LIP-  STR FIN- NECK NECK NECK NECK BODY BODY BODY BODY BASE REST  IN- PONT BOT-    VOLUME   WGHT
 TLE ACTL PRED DIAM   HT  STR  RIM  ISH DIAM DIAM DIAM   HT DIAM DIAM DIAM   HT DIAM   PT DENT MARK  TLE ACTL PRED   FACT
NO.                       RIM   HT   HT    1    2    3         1    2    3             DIAM   HT DIAM   HT

293     0    0 23.0 10.0  0.0  5.0 14.0  0.0  0.0  0.0   75    0    0    0  115  100   83  24.  47.  231  843  816  1.000
294     0    0 17.0  7.0  0.0  3.6  9.3 23.0 26.0 33.0   67   76   74   73  105   76   63  25.  44.  199  355  378  1.000
295     0    0 20.0 12.0  0.0  4.0 15.0 30.0 37.0 45.0   69  113  108  107  137  108   91  31.   0.  245 1100 1120  1.000
296     0 1824 24.0 12.5  0.0  6.0 19.0 30.6 41.0 46.0   72   99   96   95  118   96   81  45.  51.  231  765  773  1.000
297     0 1796 23.0  8.0  0.0  6.0 15.0 30.0 36.0 38.0  103   89   91   87  145   90   75  42.  50.  281  755  794  1.000
298     0 1786 23.0  6.0  0.0  2.0  8.0 28.0 35.0 43.0  100   94   90   88  145   92   76  24.  50.  275  765  810  1.000
299     0 1819 21.5 14.0  0.0  5.0 19.0 30.0 41.0 45.0   76   99   97   96  112   98   84  45.  59.  226  760  743  1.000
300     0 1805 23.0 10.0  0.0  7.0 18.5 31.0 36.0 43.0   70  100   99   98  110  100   87  33.  55.  217  755  752  1.000
301     0 1812 22.0 11.0  0.0  3.4 14.0 28.0 38.0 44.0   73   99   96   95  120   95   81  44.  63.  234  763  770  1.000
302     0    0 21.0  6.0  0.0  5.5 12.0 28.0 31.0 33.0   61   64   62   62   96   62   51   7.  36.  178  240  214  1.000
303     0    0 21.0  0.0  0.0  0.0 10.0 30.0 33.0 45.0   71  106  103  103  120  106   87  39.  53.  223    0  883  1.000
304     0 1813 19.0 11.5  0.0  9.0 20.3 28.0 39.0 44.0   82   97   94   93  113   92   78  33.  50.  232  725  656  1.000
305     0 1821 19.0 15.0  0.0  4.0 18.0 27.0 40.0 41.0   80   98   95   94  125   94   80  53.  58.  240  755  748  1.000
306     0 1826 20.5 13.0  0.0  4.0 18.0 29.0 36.0 40.0   84   91   86    0  160   83   74  39.  54.  278  785  762  1.000
307     0    0 17.0  8.5  0.0  6.0 13.5  0.0  0.0  0.0   72    0    0    0  123   72   59  23.   0.  225  414  416  1.000
308     0    0 20.0 14.0  0.0  7.0 21.0  0.0  0.0  0.0   93    0    0    0  160   79   71  32.   0.  292  754  716  1.000
309     0    0 21.0 12.0  0.0  6.0 18.0  0.0  0.0  0.0   85    0    0    0  133   89   80  42.   0.  260  784  759  1.000
310     0    0 19.0 17.0  0.0  9.0 27.0  0.0  0.0  0.0   89    0    0    0  174   78   69  22.  46.  295  739  732  1.000
311     0    0 20.0 12.0  0.0  7.0 18.0  0.0  0.0  0.0   75    0    0    0  128  106   95  36.   0.  245 1065 1029  1.000
312     0 1793 21.0  0.0  4.6  8.6 13.6 32.0 42.0 41.0   92   96   94   94  144   97   87  30.  54.  272  855  935  1.000
313     0    0 20.0  0.0  5.0 10.0 14.0  0.0  0.0  0.0  103    0    0    0  143   95   80  40.  52.  270  769  810  1.000
314     0 1820 20.0 13.0  0.0  6.0 19.5 26.0 36.0 38.0   91   90   84   83  158   82   69  31.  52.  282  750  728  1.000
315     0 1825 20.0 14.0  0.0  5.0 19.0 27.0 39.0 39.0   80   94   91    0  127   90   81  40.  58.  244  680  710  1.000
316     0 1823  0.0 13.0  0.0  7.0 20.0 30.0 39.0 40.0   77   97   93   90  125   91   75  38.  45.  240    0  719  1.000
317     0 1817 18.5 12.0  0.0  4.5 17.0 27.0 36.0 38.0   75   97   93   90  127   90   78  30.  54.  239  780  710  1.000
318     0    0 18.0 11.0  0.0  7.0 18.0 25.0 28.0 33.0   63   75   73   71  110   80   68  44.  41.  198    0  431  1.000
319     0 1819 20.0 12.5  0.0  9.0 22.0 28.0 37.0 39.0   86   88   83   80  167   83   69  39.  53.  283    0  778  1.000
320     0    0 22.0 12.0  0.0  9.0 19.5  0.0  0.0  0.0   74    0    0    0  128   95   79  45.  58.  242  798  816  1.000
321     0    0 21.0 15.0  0.0  5.0 21.0  0.0  0.0  0.0   93    0    0    0  165   80   72  30.   0.  303  739  790  1.000
322     0    0 19.5  9.0  0.0  5.0 14.0  0.0  0.0  0.0   73    0    0    0   90   79   72  28.   0.  195  384  366  1.000
323     0    0 21.5 13.0  0.0  3.0 19.5  0.0  0.0  0.0   86    0    0    0  167   75   70  24.   0.  298  724  705  1.000
324     0    0 18.0 12.0  0.0  2.0 20.0  0.0  0.0  0.0   70    0    0    0   90   73   63  23.   0.  195  325  324  1.000
325     0    0 17.5 12.0  0.0  4.5 15.5  0.0  0.0  0.0   58    0    0    0  110   94   90  20.   0.  208  784  684  1.000
326     0    0 19.0  8.0  0.0  5.0 12.8 27.0 30.0 44.0    0   89   84   81  137   80   73  48.  42.  287  710    0  1.000
327     0 1817 23.0  8.0  0.0  4.0 14.5 30.0 37.0 42.0   80   91   87    0  155   82   78  22.  55.  269  760  718  1.000
328     0    0  0.0  0.0  0.0  2.7  0.0 27.0 35.0 39.0   92   92   89   88  132   93   77  27.  55.    0  753    0  1.000
329     0    0  0.0  0.0  0.0  0.0  0.0  0.0  0.0 41.0    0   96   94   93  138   96   78  29.  57.    0  955    0  1.000
335     0 1765 22.0  3.0  0.0  6.6 12.0 28.0 33.0 39.0   95   98   94   93  135   96   84  40.  59.  250    0  746  1.000
```

APPENDIX B. BODY STYLE MEASUREMENT DATA

(Tables 7-23)

Table 7. Probable beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
1	1737	1746	132	86	-46	1025	1017	
2	1737	1752	130	83	-47	-	1042	
3	1738	1742	134	95	-39	1070	1095	
4	1739	1749	133	92	-41	1030	1149	
6	1745	1744	125	102	-23	1035	986	See Table 10
9	1747	-	129	90	-39	-	1038	
331	1755	1752	130	95	-35	1035	1076	
20	1756	1754	130	100	-30	-	1156	
62	1773	1784	123	98	-25	1090	1067	
222	-	1767	126	87	-39	-	980	
Mean			129	93		1047	1060	
Standard deviation			3.4	6.0		24	57.6	

Table 8. Probable undersize beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity
330	1738	1747	125	82	-43	850	924
16	1753	1746	125	85	-40	975	893
10	-	1755	128	80	-48	860	894
Mean			126	82		895	904
Standard deviation			1.4	2.1		56.7	14.4

Table 9. Probable wine-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity
8	1745	1754	123	95	-28	900	945
7	1746	1756	120	98	-22	920	997
14	1753	1740	123	102	-21	-	955
30	1764	1766	120	93	-27	845	910
40	1765	1768	117	102	-15	-	911
60	1772	1763	117	90	-27	-	766
Mean			120	97		888	914
Standard deviation			2.4	4.5		31.7	72.4

Tables 7-9. The three groups date from the early 1730s to early 1770s and all have base diameters considerably larger than the body height.

Table 10. Beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
6	1745	1744	125	102	-23	1035	986	See Table 7
11	1750	1745	124	110	-14	980	1074	
15	1753	1762	119	109	-10	980	1049	
35	1765	1772	115	109	-6	945	935	
39	1765	1772	119	110	-9	-	1030	
43	1767	1776	116	108	-8	995	1007	
44	1767	1771	119	110	-9	1000	990	
45	1768	1757	124	109	-15	1085	1138	
51	1770	1783	119	100	-19	975	1000	
55	1771	1772	120	108	-12	1080	1047	
61	1773	1775	118	101	-17	1045	974	
68	1775	1784	119	110	-9	1055	1139	
75	1776	1772	119	109	-10	-	1010	
77	1777	1776	119	113	-6	1120	1129	
78	1778	1790	118	111	-7	-	1130	
84	1780	1778	118	107	-11	1075	1140	
85	1780	1772	117	105	-12	1025	1005	
90	1781	1776	118	100	-18	-	984	
92	1783	1779	118	112	-6	1093	1120	
95	1783	1771	115	105	-10	1049	981	
100	1784	1787	116	105	-11	1055	1064	
109	1786	1774	122	115	-7	-	1228	
111	1786	1773	117	110	-7	1090	1082	
114	1788	1783	116	98	-18	1015	951	
143	1795	1801	117	110	-7	1025	1072	
336	1796	1797	116	110	-6	1085	1074	
337	1796	1789	115	105	-10	995	999	
160	1807	1803	115	107	-8	-	1009	
168	1811	1794	118	97	-21	-	993	
Mean			118	107		1037	1046	
Standard deviation			2.6	4.5		45.8	68.7	

Table 11. Beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity
13	1753	1762	119	114	-5	-	1089
18	1755	1762	114	110	-4	-	919
29	1764	1770	115	120	+5	1130	1065
32	1765	1761	120	115	+5	-	1107
34	1765	1761	113	117	+4	-	956
36	1765	1760	113	117	+4	-	983
37	1765	1777	113	114	+1	1140	1056
38	1765	1780	114	113	+1	1050	1065
41	1766	-	118	117	-1	-	1120
42	1767	1755	123	120	-3	1120	1183
56	1771	1767	119	120	+1	1210	1220
69	1775	1777	118	115	-3	1136	1100
71	1775	1778	115	114	-1	1155	1093
73	1776	1773	117	118	+1	-	1072
74	1776	1777	115	120	+5	1087	1103
86	1780	1776	117	117	0	-	1072
89	1781	1784	117	112	-5	-	1063
93	1783	1778	118	113	-5	1155	1130
103	1785	1774	114	112	-2	-	1010
108	1785	1776	116	112	-4	970	1045
117	1789	1783	115	110	-5	1095	1122
123	1791	1795	111	114	-3	1065	1046
128	1793	1793	116	111	-5	-	1007
129	1793	1788	114	115	+1	1055	1084
130	1793	1769	116	111	-5	1135	1102
131	1793	1785	116	117	+1	1225	1170
145	1795	1789	109	113	+4	1051	992
147	1798	-	119	117	-2	1250	1241
148	1799	1793	114	110	-4	1065	1001
156	1802	1797	113	115	+2	1120	1047
Mean			116	115		1117	1075
Standard deviation			2.8	3.1		66.2	71.1

Table 12. Beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity
33	1765	-	114	125	+11	-	1112
57	1771	1789	110	120	+10	-	1054
338	1796	1784	114	120	+6	1055	1037
339	1796	1791	113	120	+7	-	1047
150	1800	1800	113	120	+7	1180	1121
155	1802	1791	110	117	+7	-	1002
157	1803	1797	113	125	+12	-	1102
280	-	1795	113	125	+12	1075	1102
251	-	-	118	125	+9	-	1110
Mean			113	122		1103	1076
Standard deviation			2.2	2.9		54.8	39.7

Tables 10-12 represent large beer-style quarts whose base diameter and body heights are approximately the same. The bottles in Table 12 have slightly taller bodies and appear to have been introduced about 10 years later than the other two variants. This group is closer to the earlier style (Table 7) than it is to the wine-style group in Tables 16-17.

Table 13. Undersize beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity
246	-	1779	106	97	-9	750	720
237	-	1790	107	100	-7	780	819
241	-	-	112	93	-19	790	736
Mean			108	97		773	758
Standard deviation			2.6	2.9		17	43.4

Table 14. Undersize beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity
12	1753	-	109	107	-2	800	-
333	1762	1754	105	110	-5	850	782
334	1762	1763	108	110	-2	855	739
227	-	1769	108	105	-3	865	818
249	-	1773	103	105	+2	775	709
233	-	-	105	105	0	828	684
235	-	-	108	110	+2	825	834
Mean			107	107		828	761
Standard deviation			2.1	2.3		29.7	55

Table 15. Undersize beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
25	1763	1774	103	123	+20	850	819	
76	1777	1784	106	120	+14	915	907	
94	1783	1782	104	122	+18	855	881	
159	1806	1800	104	125	+21	950	920	See Table 18
223	-	1753	109	115	+6	905	850	
225	-	1761	100	120	+20	815	766	
224	-	1762	101	120	+19	-	774	
228	-	1764	105	115	+10	795	828	
243	-	1769	104	130	+26	860	858	See Table 16
226	-	1771	104	120	+16	843	835	
244	-	1771	107	115	+8	880	875	
239	-	1773	106	130	+24	870	907	See Table 16
221	-	1774	107	120	+13	870	883	
236	-	1778	104	120	+16	855	881	
240	-	1779	102	115	+13	845	818	
255	-	1786	100	111	+11	720	703	
275	-	1802	100	115	+15	785	773	
300	-	1805	100	110	+10	755	752	
232	-	-	107	115	+8	828	907	
234	-	-	104	115	+11	769	812	
239	-	-	106	115	+9	830	773	
250	-	-	106	112	+12	795	812	
252	-	-	100	116	+16	815	-	
269	-	-	99	110	+11	739	703	
293	-	-	100	115	+15	843	816	
303	-	-	106	120	+14	-	883	
Mean			104	118		833	829	
Standard deviation			2.8	5.2		54.2	61.0	

Tables 13-15 represent undersized beer-style quarts. Smaller in diameter and shorter in height than the bottles in Tables 10-12, they echo the body height/base diameter proportions of the bigger group as well as its date ranges.

Table 16. Wine-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
24	1761	1782	99	130	+31	930	849	
332	1761	-	97	135	+38	-	871	
28	1764	1758	98	127	+29	810	805	
53	1770	1756	97	134	+37	705	761	
54	1770	1778	98	130	+32	820	819	
59	1771	-	94	139	+45	769	859	
72	1776	1796	97	139	+42	903	899	
82	1779	1772	98	135	+37	867	854	
102	1785	-	95	137	+42	-	816	
104	1785	1781	97	137	+40	781	823	
105	1785	1783	97	135	+38	-	830	
116	1788	1798	98	129	+31	769	826	
132	1793	1788	98	138	+40	880	932	
144	1796	1799	92	132	+40	675	729	
230	-	1752	96	127	+31	775	733	
229	-	1755	97	133	+36	830	775	
231	-	1765	95	121	+26	680	654	
335	-	1765	96	135	+39	-	746	
243	-	1769	104	130	+26	860	858	See Table 15
239	-	1769	106	130	+24	870	907	See Table 15
247	-	1777	94	135	+41	720	750	
133	-	1790	97	133	+36	738	802	
253	-	1790	96	127	+30	760	786	
270	-	1793	94	125	+31	760	678	
261	-	1795	99	127	+28	855	786	
290	-	1795	97	123	+26	810	768	See Table 19
262	-	1796	97	130	+33	800	795	
263	-	1800	97	125	+28	790	768	
274	-	1803	95	127	+32	765	763	
292	-	1804	99	128	+29	832	842	
271	-	1809	97	130	+33	788	844	
273	-	1813	90	127	+37	720	669	
254	-	-	95	130	+35	-	783	
288	-	-	93	137	+44	710	726	
328	-	-	93	132	+39	753	-	
329	-	-	96	138	+42	-	955	
Mean			97	131		790	802	
Standard deviation			2.9	4.7		64.2	68.9	

Table 17. Wine-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity
46	1769	1766	93	145	+52	755	808
48	1770	-	99	154	+55	-	958
49	1770	1770	99	145	+46	-	996
50	1770	-	97	145	+48	910	942
52	1770	1786	93	140	+47	-	764
58	1771	-	95	145	+50	-	850
63	1773	1782	96	140	+44	-	820
64	1774	-	94	142	+48	825	845
65	1774	1775	95	151	+56	900	863
66	1774	1779	92	150	+58	910	836
67	1775	-	94	140	+46	820	879
70	1775	1783	95	150	+55	925	946
79	1779	1782	99	144	+45	-	936
81	1779	1784	97	145	+47	839	921
83	1779	1782	97	142	+45	867	892
87	1781	1761	92	154	+62	-	830
96	1783	1785	93	152	+59	795	907
97	1784	-	90	150	+60	-	794
101	1784	1802	93	152	+59	-	894
106	1785	-	95	140	+45	805	843
110	1786	1783	101	146	+45	950	1067
112	1787	1799	94	152	+58	-	899
115	1788	1786	98	140	+42	750	833

122	1791	1771	97	150	+53	-	878
126	1793	1794	96	143	+47	845	895
127	1793	1791	95	147	+52	-	884
134	1793	1806	92	149	+57	-	907
135	1793	1798	92	149	+57	-	855
136	1794	1799	92	147	+55	-	842
137	1794	1796	92	142	+50	775	817
138	1794	1801	93	142	+49	840	861
139	1794	1805	95	146	+41	-	911
140	1794	1790	93	150	+47	867	874
141	1794	1795	93	145	+42	800	861
146	1797	1801	95	142	+47	-	891
151	1800	1803	91	142	+51	-	806
153	1801	1799	92	155	+63	-	862
248	-	1778	95	150	+55	825	863
91	-	1780	93	152	+59	776	854
298	-	1786	92	145	+53	765	810
267	-	1793	92	145	+53	740	791
312	-	1793	97	144	+47	855	935
297	-	1796	90	145	+55	755	794
256	-	1797	91	146	+55	730	806
277	-	1799	91	152	+61	850	831
245	-	-	90	150	+60	737	-
313	-	-	95	143	+48	769	810
Mean			94	146.5		821	869
Standard deviation			2.6	4.2		61	58

Tables 16-17 represent wine-style quarts with tall cylindrical bodies. Introduced in the 1760s this group makes a sudden departure from the earlier squatter forms (Tables 7-9). The shorter bodies in Table 16 tend to disappear in the early 19th century.

Table 18. Beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
124	1792	1790	105	128	+23	1010	978	
159	1806	1800	104	125	+21	950	920	See Table 15
162	1809	1806	108	118	+10	-	966	
163	1809	1814	108	125	+17	-	1059	
164	1809	1807	108	126	+18	-	1042	
165	1809	-	108	120	+12	-	1025	
171	1814	1816	107	135	+28	1045	1091	
175	1815	1810	107	139	+32	1150	1134	
180	1818	1808	106	135	+29	-	1029	
181	1818	1807	105	136	+31	-	986	
183	1820	1816	106	134	+28	1115	1063	
184	1820	1830	109	127	+18	-	1096	
186	1822	1809	106	133	+27	1085	1097	
189	1823	1830	102	142	+40	-	1040	
190	1823	1819	104	143	+39	-	1089	
194	1826	1811	107	138	+31	-	1066	
195	1826	1825	104	127	+23	1027	976	
200	1836	1833	103	142	+39	1137	1060	
201	1836	1842	104	143	+39	1160	1081	
276	-	1808	109	140	+31	-	1132	
209	-	1827	103	145	+42	1160	1068	Ricketts
215	-	-	104	143	+39	-	1064	Ricketts
295	-	-	108	137	+29	1100	1120	
311	-	-	106	128	+22	1065	1029	Finishing tool
Mean			106	134		1084	1050	
Standard deviation			2	7.7		63.6	53.5	

This table represents the large beer-style quart bodies introduced in the late 18th century. Examples in the dated sample date as late as the mid 1830s but the style was probably still being made later.

Table 19. Undersize beer-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
187	1822	1819	97	116	+18	768	728	Ricketts
290	-	1785	97	123	+26	810	768	See Table 16
264	-	1796	97	117	+20	710	728	
284	-	1801	96	122	+26	785	766	
260	-	1803	99	122	+23	760	800	
301	-	1812	95	120	+25	763	770	
304	-	1813	92	113	+21	725	656	
279	-	1815	96	115	+19	765	739	
317	-	1817	90	127	+37	780	710	
285	-	1818	94	125	+31	790	754	
299	-	1819	98	112	+14	760	743	
305	-	1821	94	125	+31	755	748	
316	-	1823	91	125	+34	-	719	
296	-	1824	96	118	+22	765	773	
217	-	1825	97	117	+20	795	728	Ricketts
315	-	1825	90	127	+37	680	710	
214	-	-	98	117	+19	-	756	Ricketts
[illegible]	-	-	96	120	+24	800	739	Ricketts, no pontil
[illegible]42	-	-	97	117	+20	690	662	Group 2 finish, possibly an early wine
309	-	-	89	133	+44	784	759	No pontil?
320	-	-	95	128	+33	798	816	Finishing tool
325	-	-	94	110	+16	784	684	Finishing tool
Mean			95	120		763	739	
Standard deviation			2.8	5.7		35.2	38.5	

Table 19 represents the undersized beer-style quarts that are recognized from historical documentation as being for ale, beer, or porter (see Fig. 60).

Table 20. Wine-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
118	1790	1787	89	147	+58	-	801	
152	1800	1793	86	150	+64	-	732	
158	1805	1808	86	159	+73	-	766	
166	1809	1813	89	153	+64	-	850	
177	1817	1800	88	154	+66	810	807	
179	1817	1804	89	158	+69	-	825	
188	1822	-	88	149	+61	-	-	
196	1827	1826	84	155	+71	-	710	
197	1828	1819	83	150	+67	760	741	
198	1829	1834	84	151	+67	790	726	
202	1836	1817	83	151	+68	-	714	
204	1838	1833	84	154	+70	770	726	
205	1840	1834	84	146	+62	750	720	
206	1840	1827	85	146	+61	-	710	
207	1846	-	84	150	+66	-	710	
259	-	1795	89	150	+61	715	753	
289	-	1795	86	152	+66	-	743	
258	-	1800	89	154	+65	780	807	
265	-	1806	89	150	+61	780	801	
286	-	1807	88	143	+55	730	737	
266	-	1809	86	143	+57	740	743	
272	-	1816	85	150	+65	700	726	
327	-	1817	82	155	+77	760	718	
314	-	1820	82	158	+76	750	728	
210	-	-	83	153	+70	769	704	Ricketts
213	-	-	85	152	+67	-	715	Ricketts
218	-	-	82	153	+71	760	697	Ricketts, no pontil
268	-	-	87	152	+65	784	-	
Mean			86	150		759	747	
Standard deviation			2.4	9.5		27.5	41.3	

Table 21. Wine-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
149	1800	1821	87	164	+77	-	842	
154	1801	-	90	161	+71	785	831	
167	1810	1816	85	160	+75	-	782	
169	1813	1804	90	160	+70	880	856	
182	1808	1808	87	168	+81	845	801	
199	1834	1839	84	160	+76	-	803	
283	-	1811	89	165	+76	755	856	
287	-	1818	85	165	+80	800	827	
319	-	1819	83	167	+84	-	778	
306	-	1826	83	160	+77	785	762	
281	-	-	80	168	+88	739	754	
282	-	-	85	165	+80	-	-	
308	-	-	79	160	+81	754	716	Finishing tool
321	-	-	80	165	+85	739	790	Finishing tool
323	-	-	75	167	+92	724	705	Finishing tool
Mean			84	164		781	793	
Standard deviation			4.2	3.1		47.4	46.0	

Table 22. Wine-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
172	1815	1811	88	170	+82	835	904	
173	1815	1804	87	170	+83	-	848	
174	1815	1801	88	172	+84	-	855	
178	1817	1802	86	170	+84	850	847	
310	-	-	78	174	+96	739	732	Finishing tool
Mean			85	171		808	837	
Standard deviation			3.8	1.6		49.2	56.7	

Tables 20-22 represent the acceptable variations for the wine-style quart, beginning in the late 18th century through the first half of the 19th century.

Table 23. Imperial wine-style quarts

Bottle number	Actual date	Estimated date	Base diam.	Body height	Body height minus base diam.	Filling capacity	Estimated capacity	Comments
193	1825	1826	102	159	+57	-	1160	
216	-	1840	98	159	+61	1130	1110	Ricketts

Table 23 presents wine-style quarts in imperial measure. The base diameters are greater than the regular wine-style "quarts" (Tables 20-22) and the bodies taller than the large beer-style "quarts" (Table 18). This group dates after 1825.

APPENDIX C. AGE ESTIMATION OF OLD ENGLISH WINE BOTTLES

by C. Vithayasai, P. Cohen, and R. Aylesworth

Summary

Linear regression procedures are used to estimate the age and volume of old English wine bottles (1735-1850). Age estimates are made using whole bottles, neck fragments only, and body fragments only. Volume estimates are based on base diameter and bottle height minus neck height. It is 95 per cent certain that the error in the estimate of the volume will be less than 12 per cent.

If one uses the whole bottle formula to estimate the bottles' age, it is 95 per cent certain that the age estimate will be within about ±16 years of the true age of the bottle.

If one has only a neck fragment of the bottle then it is 95 per cent certain that the regression estimate of the bottles' age obtained from the neck fragment formula will be within about 23 years of the true age of the bottle.

If one has only body fragments it is 95 per cent certain that the regression estimate of the bottles' age will be within about 35 years of the true age of the bottle.

Data and Analysis

Twenty-three pieces of dimensional data obtained on 161 whole English wine bottles with dates ranging from 1737 to 1858 were used in a stepwise linear regression to estimate the age of the bottle. The variables used in the regression are listed in Table A1.

If the lip indicator is 2 (older bottles), then the finish height (X7) is equal to the lip to string rim height (X4) plus the string rim height (X6).

If the lip indicator is 1 (newer bottles), then the finish height (X7) is equal to the lip height (X3) plus the string rim height (X6).

Because some bottles were not whole there were more neck fragment and body fragment data (respectively 169 and 179).

In all cases a stepwise forward and backward procedure was used to pick the best set of descriptive variables. The criterion for selecting the best set was the root mean square error. If the X variables are all at their mean value then this value represents the standard error of the estimate and two times this error represents a 95 per cent confidence interval. When the X variables used to derive the estimates are not at their mean value then this estimate of the error is conservative. Thus estimates that are within a few years of the mean (1785) will be slightly more accurate than estimates nearer the extreme (1737 and 1858).

In addition, in the case of neck and body fragments, the choice of variables was made on the basis of minimizing the root mean square error while using a set of fragment variables that is most likely to be found.

Table A1. Whole bottle dimension variables

Number	Name	Min. value	Max. value
X 2	Bore diameter	17	28
X 3	Lip height	0	22
X 4	Lip to string rim	0	6
X 5	Lip width	0	13
X 6	String rim height	0	13
X 7	Finish height	8	28
X 8	Neck diameter 1	24	35
X 9	Neck diameter 2	30	41
X10	Neck diameter 3	34	58
X11	Neck height	61	115
X12	Body diameter 1	62	164
X13	Body diameter 2	72	142
X14	Body diameter 3	81	131
X15	Body height	82	172
X16	Base diameter	83	174
X17	Resting point diameter	72	117
X18	Indent height	10	54
X19	Pontil mark diameter	42	81
X20	Push mark diameter	0	48
X21	Bottle height	193	298
X22	Volume	400	2360
X23	Lip	1.4	22
X24	Lip indicator	1	2

Volume Estimates

The volume formula that was derived is listed in Table A2.

The R^2 value indicates that 96.58 per cent of the variability in the volume of the bottles can be explained using the regression formula, and the SEE value (standard error of the estimate or root mean square error) indicates that 95 per cent of the time the error in the volume estimate will be within 2(5.929%) = 11.85% of the true value.

Thus if we had the following measurements for the bottle:

X16 - base diameter = 132
X21 - bottle height = 197
X11 - neck height = 74

then the regression estimate of the log of the volume would be

$$\begin{aligned} \log_e(\text{vol.}) &= -9.3011 + 1.97 \log_e (132) \\ &\quad +1.3729 \log_e (197-74) \\ &= -9.3011 + 9.62 \\ &\quad +6.6066 \\ &= 6.924 \\ \text{so volume} &= 1017 \end{aligned}$$

In this case the actual volume of the bottle was known to be 1025 so that the error in the estimates (1025-1017)/1025 = 0.7804, which is as predicted less than the approximate confidence bound (11.85%).

In addition, it is noteworthy that all of the coefficients in the regression are significant.

Table A2. Volume formula

$$\log_e (\text{vol.}) = -9.3011 + 1.97 \log_e (\text{base diam.}) + 1.3729 \log_e (\text{shoulder})$$

where shoulder = bottle height (X21) - neck height (X11)

$R^2 = 0.9658$
SEE = 0.05925

Predictor variable	Coeff.	SD (coeff.)
Constant (X0)	-9.3011	0.21300
Base diam. (X16)	1.9700	0.027571
Shoulder (X21-X11)	1.3729	0.029395

Whole Bottle Age Estimate

The regression formula derived to estimate the age of a whole old English wine bottle is listed in Table A3.

Thus if we have the following measurements for the bottle:

	Coeff.	Value	Coeff. * value
X0	1779.5	1	1779.5
X9	1.1183	33	36.9
X11	-1.2207	74	-90.33
X15	-0.65191	86	56.06
X16	-1.1309	132	149.3
X17	0.79558	105	83.53
X19	0.41244	62	-25.56
X21	0.86582	197	170.56
X23	2.7918	0	0
X24	-6.6852	1	6.6852
Total			1742.6

the estimated date of the bottle is 1742.6. In fact the date of the bottle used in the example was 1737. Thus in this case the error in the estimate 1742.6 - 1737 = 5.4 years is much less than the approximate 95 per cent confidence interval error of ±2(7.7) = ±15.4 years.

One interesting feature of this formula demonstrated in Table A3 is the impact that a particular dimension of the bottle has on the estimate of the age of the bottle. In Table A3 the mean, min., and max. value of the independent X variables are listed. (Thus, for example, the base diameter ranges from 83 mm to 134 mm). These ranges of values times their coefficients will give the user of the formula some idea of the contribution of the particular parameter. Thus, for example, variations in pontil mark diameter can only affect the age estimate by at most 33.4 - 17.3 = 16.1 years whereas variations in bottle height can affect the age estimate by 258.0 - 167.1 = 90.9 years.

Neck Fragment Age Estimates

The regression formula derived to estimate the age of a neck fragment of an old English wine bottle is listed in Table A4. The procedure for using this formula is the same as that for using the whole bottle formula (see Whole Bottle Age Estimate).

If one compares the whole bottle formula (Table A3) with the neck fragment formula (Table A4), it is evident that the percentage of the variability explained by the neck formula is much less than that explained by the whole body formula (78.32% vs. 87.07%). Similarly the standard error of the estimate also increases from 7.7 years to 11.2 years. In this case the approximate 95 per cent confidence bound is ±22.4 years. This, of course, is because there is less information available in a neck fragment.

Body Fragment Age Estimates

The regression formula derived to estimate the age of an old English wine bottle from its body fragment is listed in Table A5. The procedure for using this formula is the same as that for using the whole bottle formula (see Whole Bottle Age Estimate). If one compares the body fragment formula with the whole body and the neck fragment formulas (Tables A3 and A4) it is evident that of the three, body fragments are the worst predictors of age. In this case the approximate 95 per cent confidence bound is 2(16.5) = 33 years.

Conclusion

In this report some of the work done by Vithayasai on using linear regressions to date old English wine bottles has been presented. This interesting approach to estimating the date of old English wine bottles works because as time progressed the old English wine bottles became narrower (base diameter, X16) and taller (bottle height, X21).

The results presented also indicate the obvious: if one has a whole bottle to measure, the estimate of date will be more accurate. In the whole bottle formula the estimate had an approximate 95% confidence bound of 15.4 years. In the case when one used the body fragment, the estimate had an approximate 5% chance of being in error by more than 33 years.

In addition to the date estimates this report also contains a procedure for estimating volume of the wine bottle from its base diameter and shoulder height.

Table A3. Formula for estimating age of whole English wine bottles (SEE = 7.7 years; R^{-2} = .8707)

				Minimum		Mean		Maximum	
		Coeff.	SD(coeff.)	Value	Contr.[a]	Value	Contr.	Value	Contr.
Constant	X0	1779.5	28.660	-	1779.5	-	1779.5	-	1779.5
Neck diam. 2	X9	1.1183	0.37991	30	33.5	35.5	39.7	41	45.9
Neck height	X11	-1.2207	0.14401	61	-74.5	86.8	-106.0	115	-140.4
Body height	X15	-0.65191	0.16126	82	-53.5	126.3	-82.3	172	-112.1
Base diam.	X16	-1.1309	0.25072	83	-93.9	106.6	-120.6	134	-151.5
Rest. pt. diam.	X17	0.79558	0.24211	72	57.3	90.4	71.9	117	93.1
Pont. mark diam.	X19	-0.41244	0.14317	42	-17.3	54.5	-22.5	81	-33.4
Bottle height	X21	0.86582	0.14073	193	167.1	249.1	215.7	298	258.0
Lip	X23	2.7918	0.27097	1.4	3.9	7.2	20.1	22	61.4
Lip indicator	X24	-6.6852	2.1991	1	-6.7	1.22	-8.2	2	-13.4
Total							1787.3		

[a] Contr. = Coeff.*value

Table A4. Formula for estimating age of neck fragment of old English wine bottles (SEE = 11.2 years; R^{-2} = .7832)

		Coeff.	SD(coeff.)	Minimum		Mean		Maximum	
				Value	Contr.[a]	Value	Contr.	Value	Contr.
Constant	X0	1740.0	20.074	-	1740.0	-	1740.0	-	1740.0
Bore diam.	X2	-1.1332	0.48740	17	-19.3	21.4	-24.3	28	-31.7
Finish height	X7	1.7357	0.54397	8	13.9	13.5	23.4	28	48.6
Neck diam.	X8	2.0156	0.52749	24	48.4	28.9	58.2	35	70.5
Lip	X23	2.1880	0.55555	1.4	3.1	7.2	15.6	22	48.1
Lip indicator	X24	-20.296	2.5044	1	-20.3	1.27	-24.8	2	-40.6
Total							1788.1		

[a] Contr. = Coeff.*value

Table A5. Formula for estimating age of body fragment of old English wine bottles (SEE = 16.5 years; $R^{-2} = .4812$)

				Minimum		Mean		Maximum	
		Coeff.	SD(coeff.)	Value	Contr.[a]	Value	Contr.	Value	Contr.
Constant	X0	1925.1	18.218	-	1925.1	-	1925.1	-	1925.1
Body diam. 3	X14	1.3838	0.61368	81	112.1	104.3	144.3	131	181.3
Base diam.	X16	-3.2425	0.66844	83	-269.1	106.6	-345.7	134	-434.5
Rest. pt. diam.	X17	1.4577	0.41772	72	105.0	90.4	131.8	117	170.6
Indent ht. (mm)	X18	-0.47098	0.17291	10	-4.7	30.8	-14.5	54	-25.4
Pont. mark diam.	X19	-1.0197	0.24324	42	-42.8	54.5	-55.6	81	-82.6
Total							1785.4		

[a] Contr. = Coeff.*value

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The "wine" bottle was the principal product of British bottle-glass factories in the 18th and early 19th centuries. The bottles were used to ship, store, mature, and serve a variety of products, primarily beverages, and were widely used not only in Britain, but also in her colonies and in other countries that traded with Britain. For this study over 211 cylindrical sealed and dated bottles and 127 complete undated bottles were examined to establish criteria for dating cylindrical "wine" bottles made between 1735 and 1850. Four distinct body styles have been isolated: a wine-style, beer-style, undersized beer-style and imperial wine-style.

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